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POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 7.

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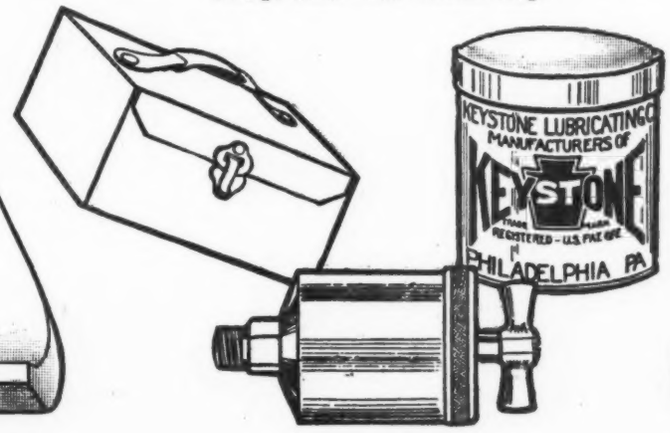

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DANNEMORA July 9th 1908.

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Buffalo, N.Y.

Dear Sir:-

I beg to hand you the following facts furnished by our Chief Engineer Mr. Robt. E. Elliot, in regard to the Dean Boiler Tube Cleaner which we have on trial.

After thoroughly cleaning our # 6 Boiler I removed 195 lbs of scale with the Dean Cleaner. I removed 260 lbs of scale from our #1 Boiler and directly after an Inspector report of " Clean Boiler " I took out 160 lbs of scale from our # 2. Boiler I have found the cleaner just as represented and consider it a valuable little machine for the Boiler Room.

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Supt. of Industries.

There you are! And maybe you've been holding off because you believe your boilers are clean. Run the Dean through the tubes and you'll be surprised at the amount of scale it will remove. In spite of your present methods of fighting scale—compounds or mechanical cleaners—the Dean will find scale. We'll loan you a Dean, free of charge, for trial on one boiler.

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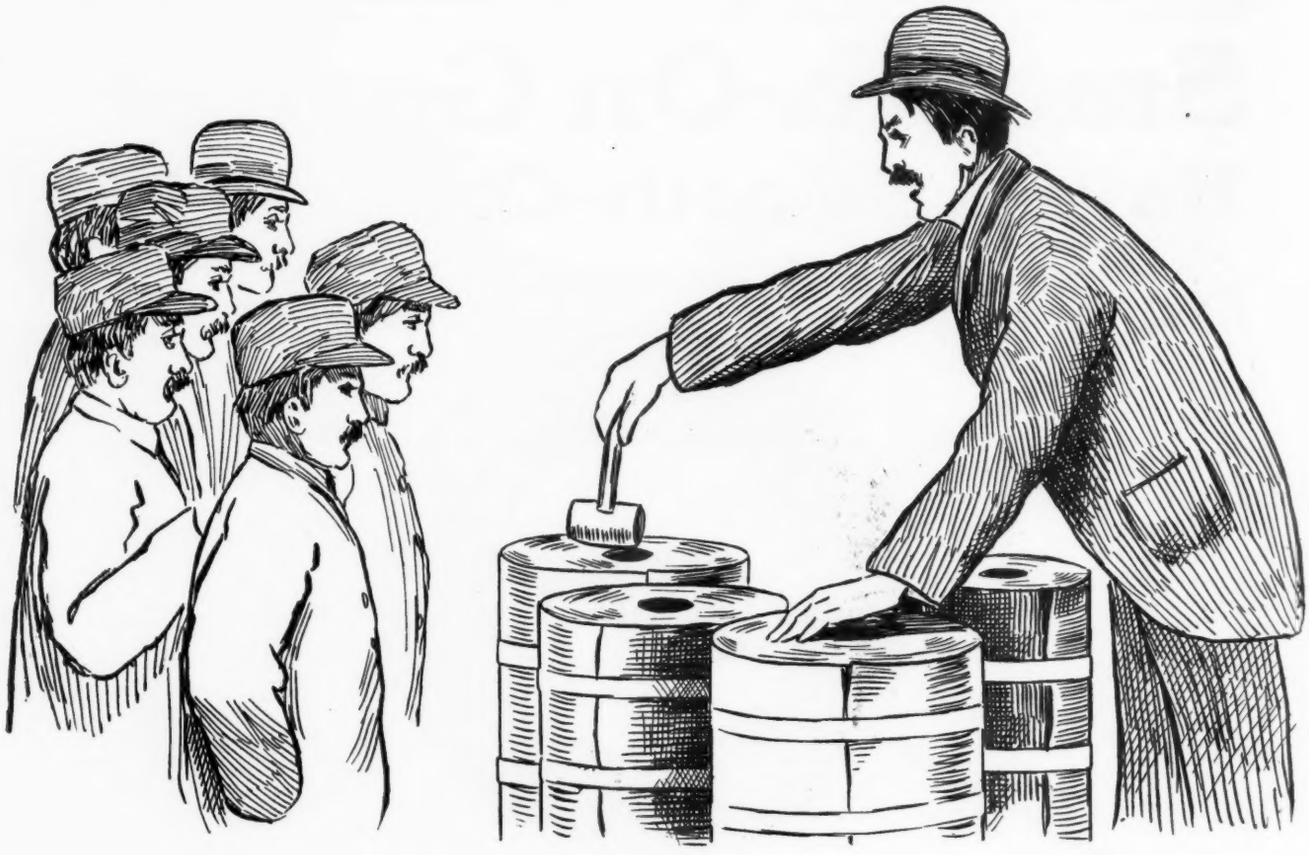

Auctioneer: "Now, gentlemen, I am going to dispose of the entire stock of the Old Fogy Packing Supply Co. What am I offered for this roll of Antiquate sheet packing? Something fine, I guess. Sure to give satisfaction. What am I offered a pound? One dollar? Seventy-five cents? Come boys, don't let this chance slip by. What will you start it at? Twenty-five cents? No bid? All right, pass it along.

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I guess, boys, you're out for something choice. Well, here it is, the choicest ever! A black sheet packing that's a Cracker-Jack. What's that? Is it Ebonite? Well, no, but I guess it's just as good." (Chorus of voices) "There is no packing that's just as good as EBONITE Black Sheet Packing. We know! We've tried Daniel's EBONITE for superheated steam, high steam pressures, hot and cold water, oil, ammonia, gas, and everywhere you can use a packing, and there isn't anything that can touch EBONITE."

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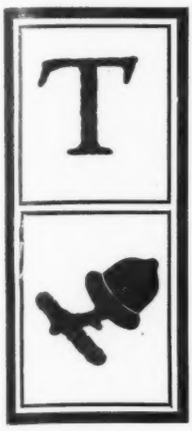
The House of Dearborn



THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

Thus began the work of the DEARBORN COMPANY. That it has been successful is attested by the fact that thousands of steam plants use their products, prepared according to analysis of the waters, and find absolute relief from the troubles formerly experienced.

With its large corps of representatives, all of whom are *mechanical experts*, working in all sections of the country, backed by the scientific laboratory work done at Chicago, the Dearborn Company is able to give personal attention to every case, making careful study of the water and plant conditions and furnishing treatment that exactly meets requirements.

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Lunkenheimer Oil and Grease Cups

are designed according to above specifications.

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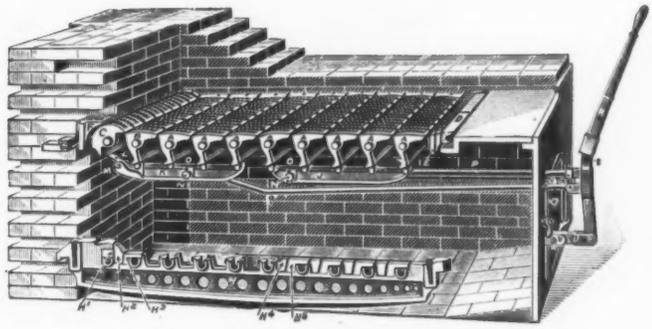
Not on the ordinary grate, but on a grate especially designed and adapted for such a purpose, i.e., the McCLAVE GRATE.

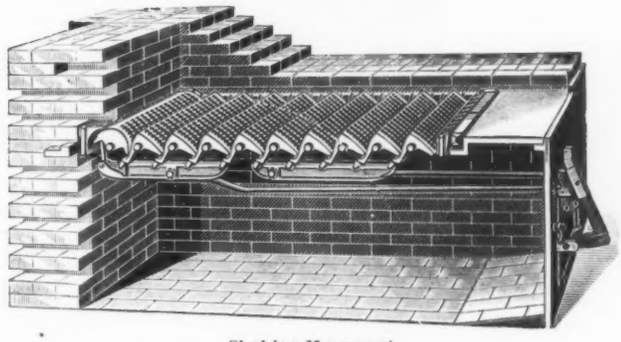
Used in combination with the ARGAND BLOWER it makes a superior system for extracting every heat unit from the cheaper classes of fuel, such as slack, screenings, birdseye, duff, etc. This places the running of any plant on a more economical basis and still guarantees the same results as if high grade fuels were burned on ordinary grates. *Better results even*, for the McClave System leaves *no waste* in the ash pit.

Write for Catalog "G".

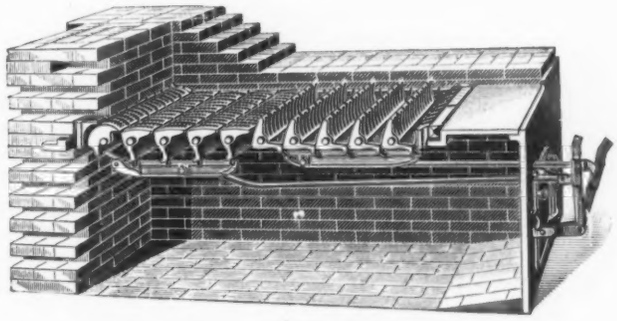
Argand Steam Blower



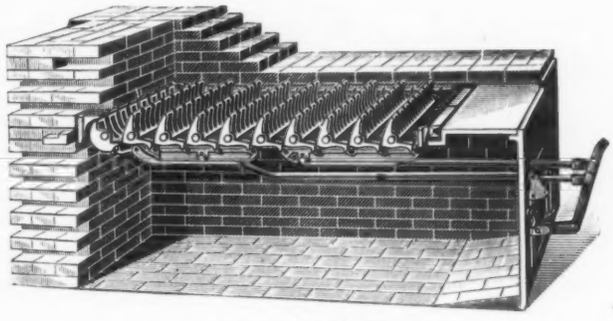
Normal Position of Grate



Shaking Movement



Divided Cut-Off



Whole Cut-Off Movement

McCLAVE-BROOKS COMPANY,

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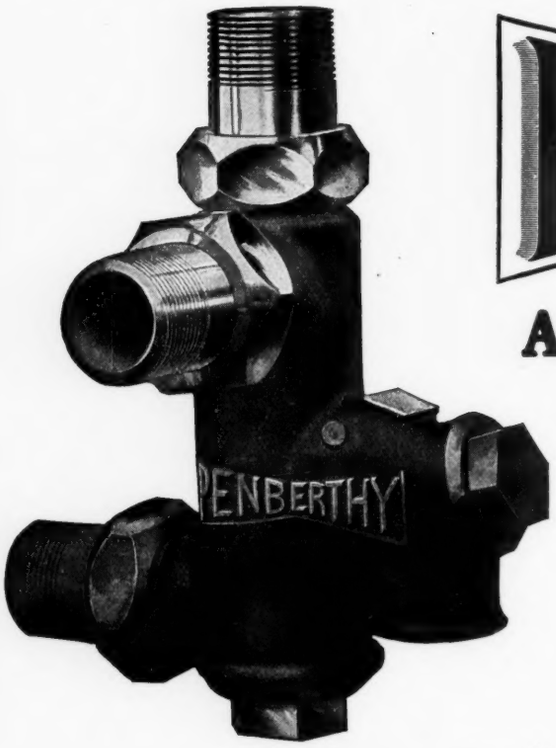

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(Reg. U. S. Pat. off.)

AUTOMATIC INJECTOR

Always "Makes Good"

1st—It will work on higher pressure and handle hotter water.

2nd—It will lift further vertically on a greater range of pressure.

3rd—It delivers a maximum amount of water with a minimum amount of steam.

Try the PENBERTHY it never fails.

TRADE PENBERTHY MARK. **"XL-96"**

EJECTOR OR SYPHON

Has no equal in lifting or elevating liquids. Used Exclusively by the leading creameries, tanneries, breweries, brickyards, distilleries and dye houses in the country.

SPECIAL "XL-96" NON-ELEVATING EJECTOR

Heats liquids to a minimum; Lifts 28 feet; Uses less steam and delivers 33⅓% more liquid than any Ejector made. A trial will convince you.

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The new "Engineer & Fireman" (80 page magazine) will be sent to any engineer who will send his name and address.

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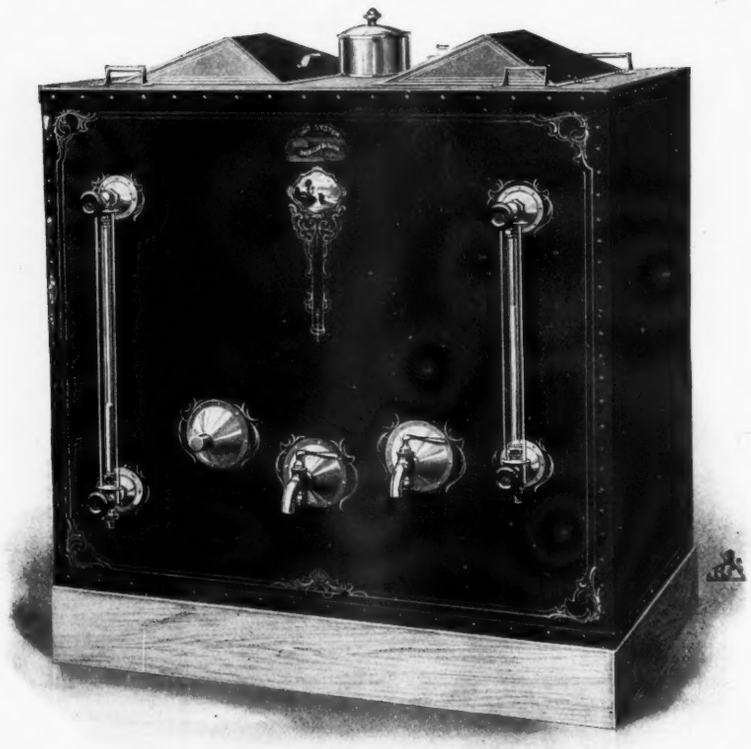


Another "Burt" Unit Filter For The Kodak People

Read What They Have To Say:

EASTMAN KODAK COMPANY
Rochester, N. Y.

The Burt Mfg. Co., Akron, O. June 17, 1908.

Gentlemen—Replying to yours of the 12th inst., would say we have installed a second of your latest improved "Unit Type" oil filters. The results obtained in the operation of an engine by having a continuous stream of pure oil delivered to the bearings is far superior to the old scheme of lubrication from oil cups. We are, therefore, very well pleased with the unit filter system and are convinced that the same will result in considerable saving, not only in the oil but in the life of the engines.

Yours truly,
Eastman Kodak Company,
P. E. Wilcox, Ass't Mgr. Kodak Park Works.

Send for our 92-page Catalog.

THE BURT MFG. CO., 232 Main St., Akron, O., U.S.A.
Largest Manufacturers of Oil Filters in the World.

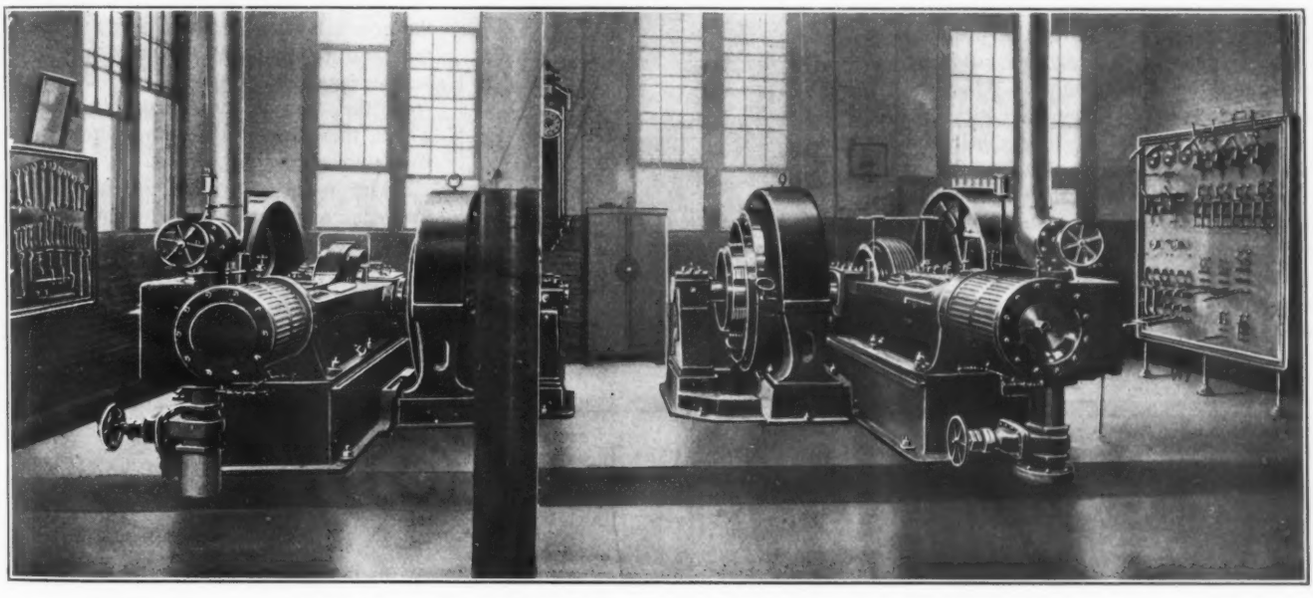
Power System of the Henry Vogt Machine Co.

An Uptodate Steam-Electric Installation Which Furnishes an Excellent Example of the Advantages of Concentration of Equipment

BY OSBORNE MONNETT

Following the custom in the design of modern industrial establishments, all the power-generating equipment of the Henry Vogt Machine Company, Louisville, Ky., has been concentrated in a convenient location for the distribution of power to the different departments. In the general plan of the works, Fig. 1, the relative positions of the several buildings are shown. The shops are equipped for the manufacture of water-tube boilers and absorption refrigerating apparatus, as well as general boiler and tank work.

Fig. 2 shows the power house, which is a one-story brick structure, with ventilators and ample window space. It is 50x100 feet in dimensions and is divided into engine and boiler rooms, with a coal-storage space in front of the boilers of about 80 tons capacity.



GENERAL VIEW OF ENGINE ROOM, HENRY VOGT MACHINE COMPANY'S PLANT

Boiler Room

As shown in the plan of the power house, Fig. 3, two boilers are installed. These are of the Vogt water-tube type, made in the shops of the company, and are rated at 300 horse-power, each having a total heating surface of 3000 square feet. Each boiler has two horizontal steam drums and the heating surface consists of three rows or banks of horizontally inclined tubes connected by cross drums. The construction of the boilers is well shown in Fig. 4.

Feed water enters the steam drums at the rear, passing directly through the two vertical rows of short tubes, to the mud drum, and then through the three banks of tubes previously mentioned, back into the steam drums. From the construction of the fire-brick baffling, it is evident that the gases must pass the length of the tubes three times before escaping to the stack. Fig. 4 gives an excellent view of the method of supporting the boilers on a steel framework of columns and girders, no part of the boiler proper resting on the side walls. The small cross drums are of steel construction and are riveted together, with ample openings for the passage of water and steam. They are provided at one end with a manhole, and on the sides with six handholes, which afford access to five tubes each. The sheets of these cross drums are pressed hot, in such manner that each tube has a flat surface in which to be expanded and allows the use of straight, commercial boiler tubes. After being installed, one boiler was equipped with a Roney stoker and one is still hand-fired, as shown in Fig. 5.

The boilers carry a steam pressure of 125 pounds per square inch, and this pressure is kept constant by a damper regulator of unique construction made by the engineer in charge of the plant. In the illustration of this regulator, Fig. 6, *A* is a ¼-inch pipe connecting to the steam-gage line on the boilers; *B* is an expansion tube from an old steam gage; *C* is a contact button on the gage hand, and *D* and *E* are adjustable contacts which can be set for 100 to 150 pounds, as may be desired. The contacts are generally arranged to allow about two pounds variation in steam pressure. A raise in pressure causes contact with *E*, closing the electrical circuit and allowing current to flow through the coils, which pulls down the armature *G*, closes valve *F*, opens valve *H* and allows compressed air to pass into the cylinder *I*. The air pressure raises the piston, and closes the damper through a chain connection. Valve *J* is kept open just enough so that the small whistle *K* will sound slightly and notify the fireman that the damper is closed.

When the steam pressure drops, the electric circuit is broken, the magnet releases the armature *G*, and the valve *H* is closed; simultaneously the exhaust

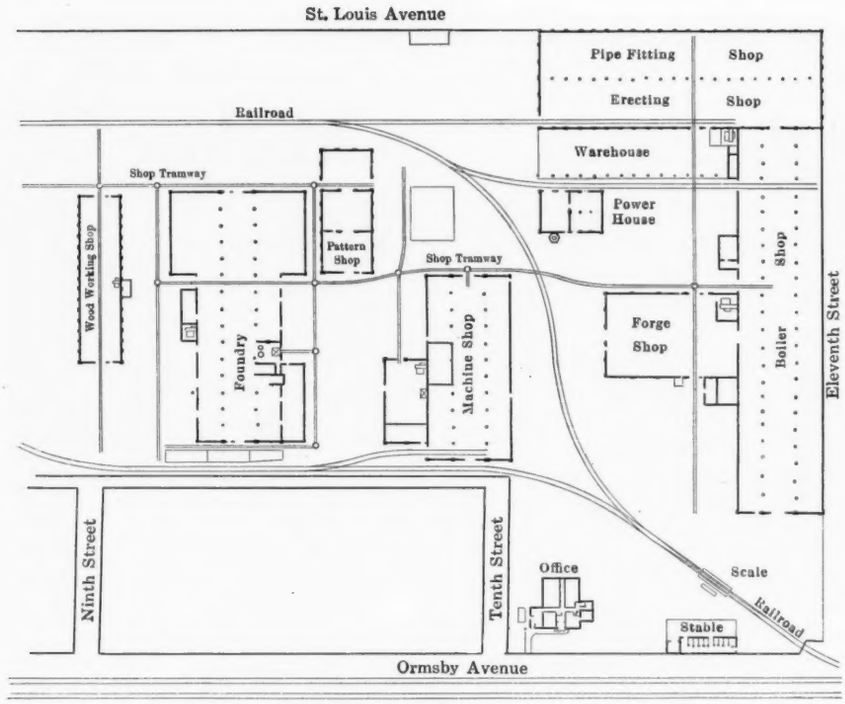


FIG. 1. GROUND PLAN OF THE WORKS OF THE HENRY VOGT MACHINE COMPANY

valve *F* opens and allows the pressure in the cylinder to be released, allowing a weight to open the damper. When the pressure drops two pounds, contact is made at *D*, ringing an electric bell and informing the fireman of the decrease in steam pressure. This damper regulator has been in use for some time with the satisfactory results shown in Fig. 7, which was taken when the plant was carrying the average shop load, varying from 250 to 325 horse-power.

FIG. 2. EXTERIOR OF POWER HOUSE

The boilers are equipped with Reliance automatic high-and-low-water alarms and Squires feed-water regulators, and are supplied by two 8x9x5-inch, single-cylinder Reilly feed pumps, controlled by Squires pump governors. Feed water is taken from a hot well in the boiler-room floor and pumped through a closed heater made by the company. This consists of a vertical shell three feet in diameter by 18 feet high, containing eighty-seven 1½-inch brass tubes. Ordinarily the feed water is raised to a temperature of 208 to 212 degrees Fahrenheit. The hot well receives the condensation from all parts of the heating system and exhaust lines, and is equipped with float regulators, which admit water from the city mains and also from the water-works system of the plant. All of the feed piping and fittings are extra heavy; all valves two inches in size or smaller are of Powell make, and all over two inches are Crane.

Nut and slack bituminous coal are used, and are obtained from the Jillico mines in eastern Kentucky. The fuel averages about 13,500 British thermal units, and 6.9 per cent. of ash. Delivered to the power house, the coal costs $1.50 per ton, and is unloaded by hand into the coal-storage bin. Ashes are shoveled from the ash-pits into small cars, from which they are loaded into dump cars for removal by the railroad.

Steam is carried from the boilers to the engine room by a 10-inch, extra-heavy, wrought-iron header, 60 feet long; at the end of this header is a 10-inch water leg three feet long, which takes care of condensation at this point. This

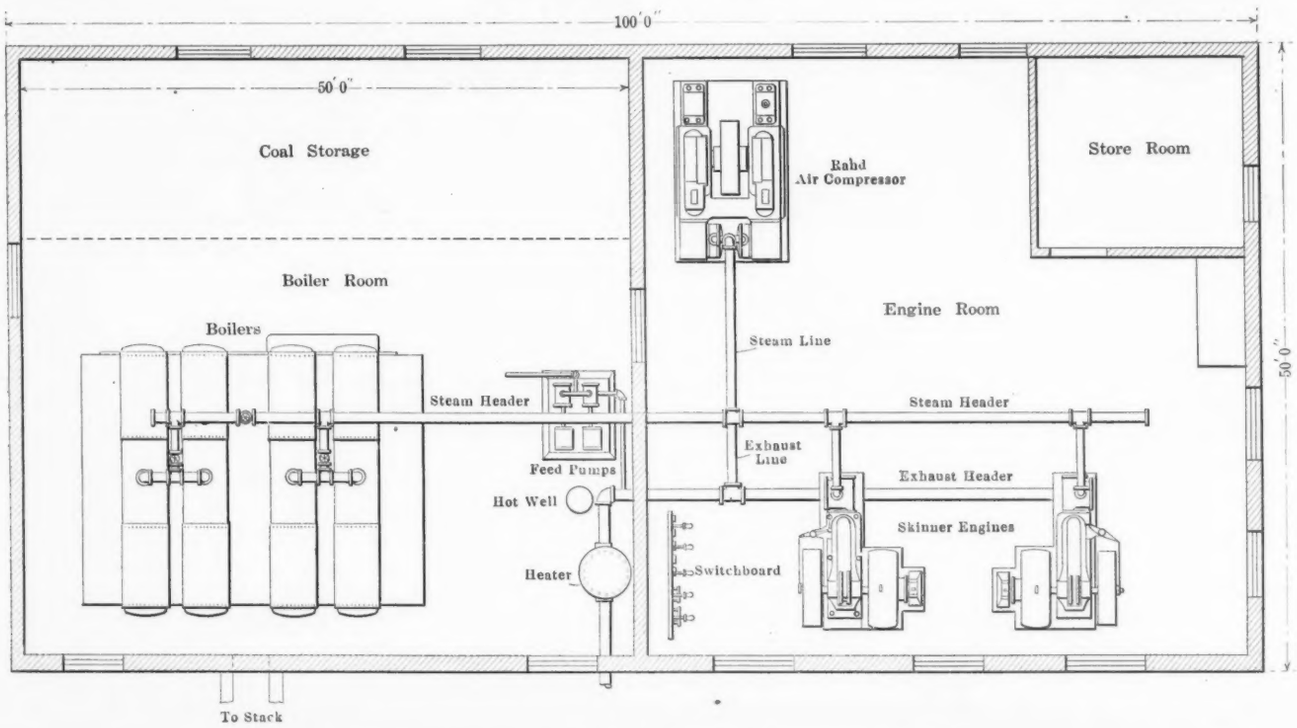


FIG. 3. PLAN OF POWER HOUSE, HENRY VOGT MACHINE COMPANY

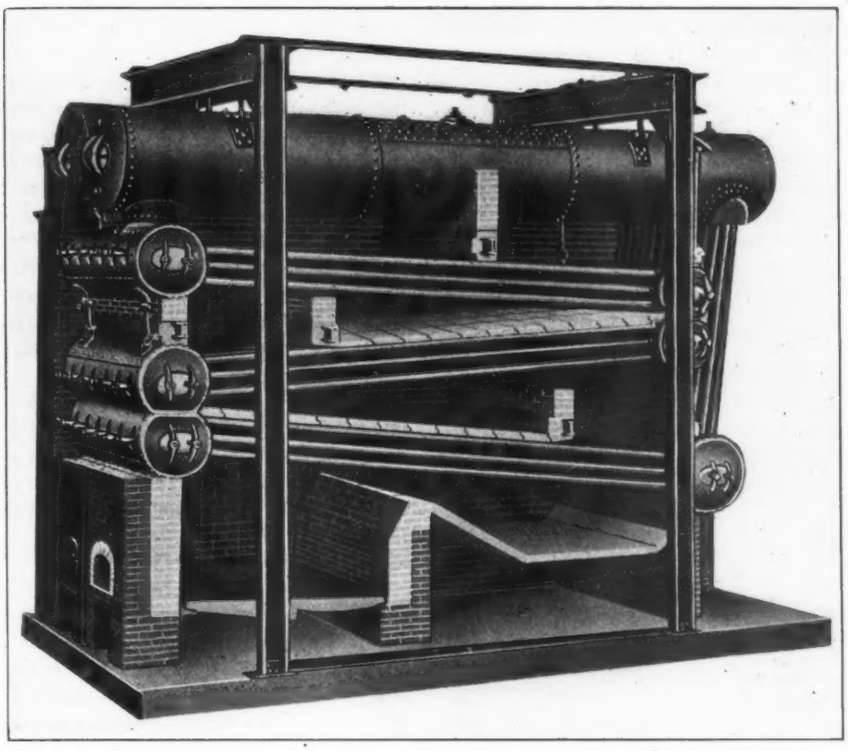


FIG. 4. SHOWING CONSTRUCTION OF BOILERS

is drained by a No. 2 Anderson steam trap returning the condensation to the hot well in the boiler room.

Engine Room

In the engine room are two generating units, consisting of one 17x18-inch and one 18x18-inch Skinner automatic engines, each direct-connected to Willey multipolar direct-current generators. Both units operate at 225 revolutions per minute, and are rated at 150 kilowatts. The engines are of the standard Skinner make, with individual automatic oiling systems which deliver a constant supply of lubricating oil to the bearings. A general view of these units is shown on page 255.

In one corner of the engine room is located a two-stage Rand air compressor, Imperial type 10, with steam cylinders 10x14-inches in size, and compound air cylinders, 16x10x14 inches. The compressor has a rated capacity of 536 cubic feet of air per minute, when operating at 165 revolutions per minute, and is equipped with an adjustable riding cut-off valve. With 125 pounds boiler pressure, it will deliver its full capacity with the cut-off set for ¼ stroke. Air is taken from above the roof and is led to the compressor by a 9-inch galvanized sheet-iron pipe, and a receiver is located in the boiler room where the air is stored for use. A chain-driven Gardner governor limits the speed of the compressor, which is also controlled by a dash-pot governor, according to the amount of air being used.

As will be seen in Fig. 8, the working parts of the compressor are entirely inclosed and run in oil. Cylinder oil is fed by Rochester automatic force-feed lubricators, one of which is also attached to each of the generator units.

Electrical Equipment

Current is generated at a pressure of 250 volts and is delivered to the switchboard through iron-armored conduits running beneath the engine-room floor. At the right in the engine-room view is the switchboard, consisting of two panels. One is a generator panel and contains two large three-pole switches, two I. T. E. circuit-breakers, two Weston ammeters and one Weston voltmeter, the latter connected so that it can be used on either machine separately or on both at the same time, when running in parallel. This panel also carries two field rheostats, one ground detector and the usual pilot lamps. The distributing panel contains four double-pole switches, four I. T. E. circuit-breakers, one for each power circuit, and five smaller switches, which are used for lighting purposes.

An interesting detail of the switchboard is the automatic alarm by which notice is given when any circuit-breaker on the board goes out. This alarm consists of a small air whistle, which is also arranged to blow every half hour regardless of whether a breaker goes out, the engine-room clock being connected into the circuit in such a way that the whistle blows automatically. Ammeter readings are taken every half hour, but it sometimes happens that the engineer is called away from the engine room and when the whistle blows and is not shut

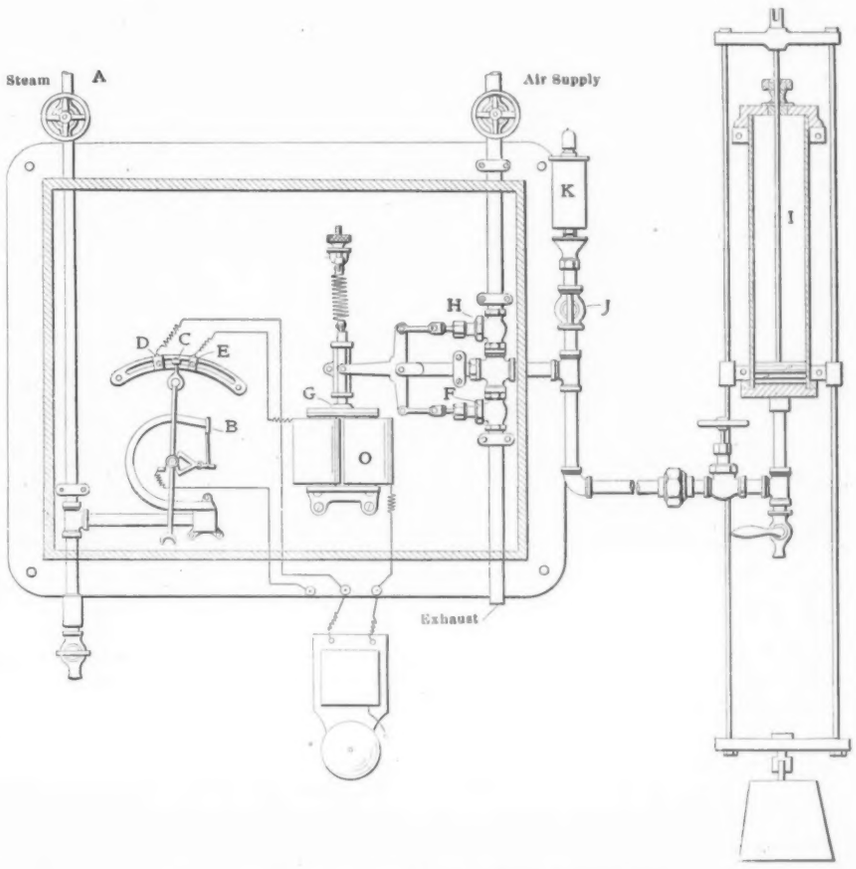


FIG. 6. DIAGRAM OF AUTOMATIC DAMPER REGULATOR

off in a reasonable length of time, the fireman is under instructions to go into the engine room and investigate. The construction and wiring of the apparatus necessary for the accomplishment of this purpose are shown in Fig. 9.

Referring to the end views of the switchboard, *A* is a small shaft extending along the top of the board; *B* is an arm held in place on the shaft by a set-screw and connected to the top of the circuit-breaker by a light spring, which is sufficiently strong to hold the weight of the arm when the circuit-breaker is in. When the breaker goes out, the shaft is pulled around in its bearings, closing the contacts *C* and *D* and allowing the current to pass through the resistance box *E*, which carries four 110-volt, 16-candle-power lamps connected in series. The current then releases the latch *F*, allowing the weight *G* to blow the whistle with compressed air. This connection is for the circuit-breakers on the distributing panel. The two main circuit-breakers operate on much the same principle, but have a special contact device for closing the electrical circuit. This device operates in a battery circuit instead of from the main generators, for the reason that when the main circuit-breaker is out, there would be no current to operate the magnet. The engine-room clock closes the alarm circuit every half hour by two small contacts placed on the dial and operated by the minute hand.

FIG. 5. BOILER FRONTS

Power and Lighting Circuits

On the power circuits the motors range from 2 to 50 horse-power, some being belted to line shafting and a number directly connected to these machines. There are a total of about fifty motors in the plant, and all are Willey machines, built by James Clark, Jr., & Co.

Three distinct power circuits lead from the engine room on overhead pole lines; the erecting shop, boiler shop and forge shop are all on one circuit. The machine shop, in which a large number of motors are installed, has an independent circuit, and the foundry, pattern shop and carpenter shop are supplied from the third power circuit. There are in all six electrical traveling cranes built by Pawling & Harnischfeger; five of these are of 10 tons and one of 20 tons capacity. The power for the cranes is taken from an independent power circuit. Lighting requires three special circuits on which are about 80 arc lights distributed throughout the plant and 800 incandescent lamps.

Exhaust and Heating Systems

A 12-inch header receives all the exhaust steam from the engine room, passing it to the heater through an Austin oil separator. Live and exhaust steam, compressed air and the water supply are distributed from the power house through tunnels; the main tunnel is 7 feet deep, 6 feet wide and 4 feet below the surface of the ground, with branches extending to each of the departments. Two 4½-inch high-pressure lines supply steam for running various steam hammers throughout the plant, testing pumps, etc., and one for delivering compressed air. One 4-inch line brings back all condensation to the power house and two 2-inch water lines carry city water.

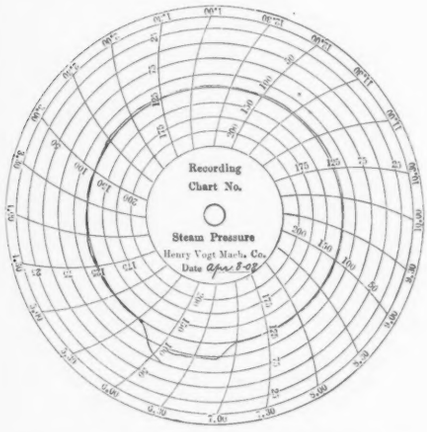


FIG. 7. STEAM CHART, WITH PLANT CARRYING FLUCTUATING LOAD

In all the buildings the Sturtevant indirect system is used for heating, air being circulated around coils of one-inch pipe and distributed to all parts of the shops by fans driven by small steam engines. Live-steam connections are attached to all heater coils, to be used in case the main engines are shut down, and the arrangement of the dampers is such that the same air can be circulated until a sufficiently high temperature has

been reached, when cold air from the outside may be drawn in.

At the end of the 4-inch condensation return is a receiver which collects the condensation as rapidly as formed, pumping it to the hot well by a Deane-of-Holyoke 6x5x6-inch duplex steam pump governed by a float in the receiver. It was found in practice that a great improvement was effected by causing a spray of cold water to flow into the receiver, this having the effect of lowering the temperature of the water and creating a partial vacuum to aid circulation.

Hydraulic Equipment

For riveting and flanging work in the boiler department, a hydraulic system carrying a pressure of 1500 pounds per square inch is installed. The pump used for this service is a Deane-of-Holyoke, of the triplex, geared, single-acting, plunger type, with cylinders three inches in diameter by 12-inch stroke. It is driven by a 50-horse-power Willey motor, governed by a Cutler-Hammer controller, and operates in conjunction with a 45-ton hydraulic accumulator.

Records of Costs

The matter of keeping records of the performance of the plant has been worked out in considerable detail. Ammeters on the switchboard are read every half hour and the electrical data are figured from these readings. The air compressor is equipped with a revolution counter, and a record of the revolutions is kept from which to figure the air output and steam consumption. The feed pumps are also equipped with counters, and by this means the total water consumption is computed. These pumps are tested for leaks three times a day, by shutting off the feed valves to the boilers, turning on a full head of steam for a period of one minute and noting the strokes made by the pump; a record of the number of strokes is kept, and the percentage of loss by leaks in pump valves, cylinders, etc., is figured from the information thus obtained. Any considerable depreciation in the condition of the feed pumps is thus detected by the additional number of strokes made when tested, and it can thus be ascertained when a pump is ready for overhauling.

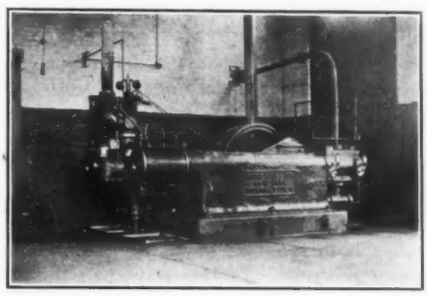


FIG. 8. RAND TWO-STAGE AIR COMPRESSOR

An evaporative test of four hours' duration is made on the boilers once a week, the object being to get the pounds of water evaporated per pound of coal. Coal delivered to the plant must contain at least 10,000 British thermal units, not more than 20 per cent. of ash, and evaporate on a practical test at least 7 pounds of water per pound of coal. If the coal does not come up to this standard, it is rejected.

The affairs of the company are under the efficient management of Henry Vogt, president, and much credit is due to George A. Pardee, chief engineer, for the satisfactory manner in which the power department is handled.

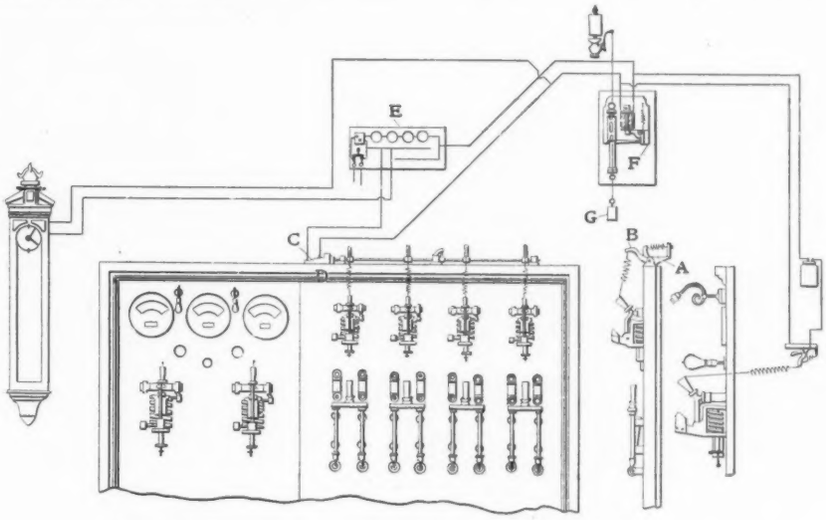


FIG. 9. DIAGRAM OF AUTOMATIC SWITCHBOARD ALARM

The Manchester Corporation has placed a contract for a 6000-kilowatt Zoelly turbine, with alternator and condensing plant, with James Howder & Co., Ltd., of Glasgow. This is the largest turbine of this type which has yet been undertaken.

Pin Hole Grate Firing

By Warren H. Miller

Pin-hole-grate firing will abate the output of smoke and cut down the coal bills of any steam plant, and it will work continuously and reliably year in and year out, no matter how thick the firemen. The simplest, as always, is the best. There are steam-blast pin-hole-grate power plants that have been running without any particular trouble for years. The fan-blast plants also do nicely, except for the occasional shut-downs of a fan engine to take up bearings.

Grate Bars

The bars of these pin-hole grates are 3 feet long by 6 inches wide and two sets of bars will make a fire-box 6 feet deep, which is about right for good hand-firing under small boilers of from 100 to 200 horse-power. For larger sizes it is permissible to go to a 9-foot grate, although 8 feet of it is all that will be fired.

At the top surface of the grate the pin holes are ⅜ inch in diameter and are spaced 1½ inches apart. In each bar there are four holes to the row and, as the rows are staggered, every alternate row has three holes and two half-holes, the latter being completed by the half-holes in the adjoining bars. The bars are 1½ inches thick and the holes taper from top to bottom to 1¼ inches diameter. As there are 27 rows of holes to the bar, the draft area figures 5.5 per cent. With an air pressure of 2 inches, the fire will be carried six or seven inches deep.

The great advantage of this system is that it permits the use of rice anthracite delivered anywhere within 400 miles of the Pittsburg district for about $1.50 per ton. It makes a hot fire which works up steam quickly, is absolutely smokeless, gives little or no trouble in the way of sooting up the economizer, is easy to handle and evaporates about 7¾ pounds of water per pound of combustible. Its chief detriment is the ash, which is very high, averaging 19 per cent., and running up to 33 per cent. in poor grades, so that ample provision should be made for ash handling and disposal. It screens to very good concrete cinder, and the fine ash is salable as filling for pavements and floors.

Steam Blast versus Fan

But little description is required for the steam blast. There are several good ones on the market, all based on the principle of a wide-mouthed injector with a small steam jet in the center. Most of them are fitted for ¾-inch supply, but the actual opening is less than ⅜ inch. While the steam blast uses more steam than

a fan, its repair account is very much less. It will not do, however, for large plants, as it uses considerably more steam than the fan for the same air delivered into the ash-pit. The fan-blast system requires more care in laying out. It simply must be in duplicate, because the fan engines have to be shut down occasionally to adjust brasses, fix up oiling devices and what not.

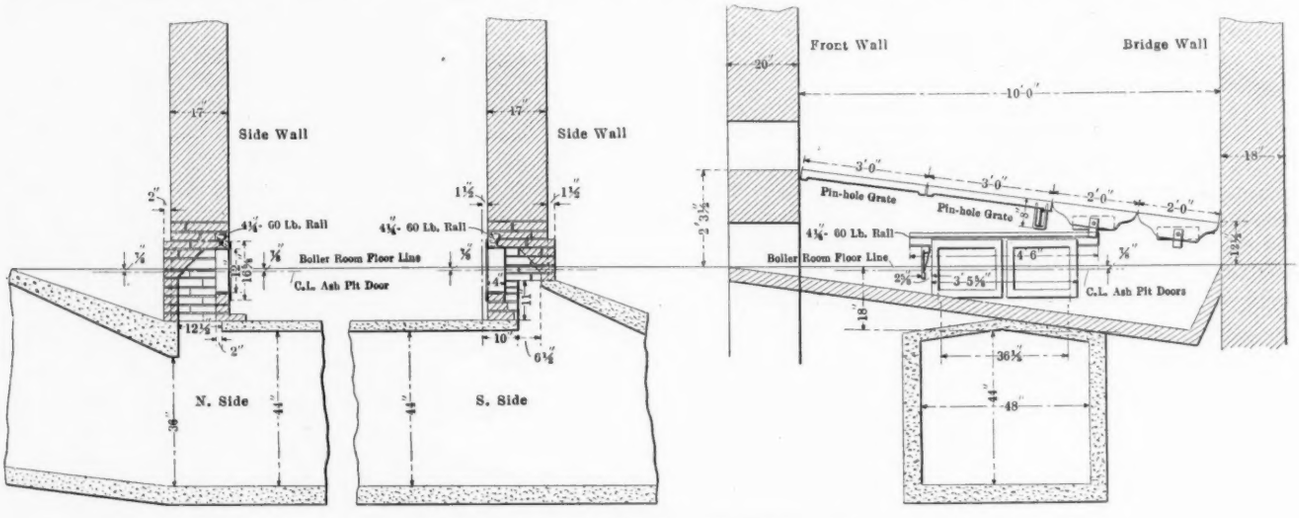
A battery of four 250-horse-power boilers will require two 60-inch fans driven by two 6x6-inch engines. Either fan will run the plant. They are located in the engine room, or, if there be a long battery of boilers, in the center of the boiler plant. For location in the engine room, the three-quarter housing type is well adapted. It delivers directly into a 48x44-inch conduit passing under the boilers. This is made of cinder concrete with 4-inch walls and 3-inch reinforced ceiling. There is a swinging cast-iron blast door opening from a conduit into each ash-pit. These doors should be built into the side walls of the ash-pits with ducts about 8x36 inches connecting to the conduit. The doors are separately operated by levers so that the blast can be shut off when cleaning fires or hoeing out the ash-pit.

Operating at 240 revolutions per minute, the fan gives a blast of 2 inches to 2½ inches water pressure. The fan in reserve must be provided with a door to prevent the entire blast from blowing back through it instead of up through the grates. Swinging doors in the conduit where the two fans empty into it would seem to solve the problem, but when one considers that the pressure on such a door would take two strong men to open it, it is better to keep it out of the conduit entirely. The simplest and strongest arrangement is a 14-gage sheet-iron door, which fits the angles on the fan housing on each side of the intake hole. Suitable clips riveted to the angles make it easy for the door to be shoved into place on the idle fan; it may be secured there with two crossbars of 1½x½-inch flat iron, corresponding precisely to the good, old-fashioned, barn-door cross bars. This door will never stick or get out of order, which is more than can be said of any swinging door that can be put into the conduit. While the size given for the conduit may seem rather large, it is well to make it so with the idea of capacity for future boilers, even if no extension is actually contemplated. When the time does come to add boilers, a small conduit is absolutely hopeless.

An important point to remember in operating these fans is to always close all damper doors and open ash-pit doors when both fans are down, no matter how short the time. In this way the chimney gets a chance to keep a draft on the fires. Otherwise the fires are not only dead, but coal gas collects in the passages under the boilers. The minute the fan is started up, this mixed coal gas and air is swept up through the grates. A frightful explosion follows, the fire doors are blown open, and the hot coals showered over the firemen. The records show that this accident has happened more than once, several firemen losing their lives thereby. A sure preventive is to have a powerful chimney. It is the attempt to do away with the chimney that is mostly responsible for such accidents.

Attached to each fan engine is an automatic pressure governor. Unlike most automatic features, it is fairly reliable, shutting off at from two to five pounds above the pressure for which it is set, and starting up some five pounds below. The makers claim one pound each way. It has one bad fault, which can be guarded against. If the speed of the fan is too high, steam will pick up very quickly and soon automatically choke off the fan. But the fire has got such an impetus that it is some time—about twenty minutes—before the fan is again called on for service. It then runs about five minutes and is again shut off. This intermittent action has two bad effects on the fan engine itself. The sudden and frequent starts are very hard on the brasses; and at each stoppage water accumulates behind the valve, and is suddenly blown into the cylinder when the automatic valve opens. Furthermore, in time this sudden rush of water breaks away the fine wire-gauze strainer which protects the delicate seat of the valve.

The remedy for all this, of course, is to experiment with the speed, adjusting the automatic valve until the fan runs nearly all the time. If there is much change in the demand for steam, this adjustment is not sufficient, but there is still the remedy of dispensing with the automatic feature altogether and letting the fireman regulate the fan engine as required, just as he does the feed pumps. To this end it should be seen that the steam globe valves of the engine have all-brass seats, so they may be used as throttles.



ASH-PIT DRAFT DOORS AND PIN-HOLE GRATE

Firing Implements

There seems to have been little published on the subject of firing implements. If the fires are of anthracite the fireman will see little of the slice bar, but if using soft coal it becomes the principal tool and will be used as a lever of the second order to lift everything from half of the caked coal in the fire box to a two-foot Welsh "dog" melted fast to the grate bars. Wherefore, none with less than a 1¼-inch handle and 3½x1¼-inch knife should be provided, the handle being finished with a 2½-inch round knob at the end. With such a slice bar at 250-pound fireman can perform all kinds of circus stunts and fail to bend it.

The usual fire hoes are all too light,

and too little attention is given to balance. For a grate 7 feet deep, a hoe that will not entail the likelihood of killing off the firemen should be twelve feet long with a handle of one-inch stock from the blade back four feet, and the rest of ⅞-inch material—all solid. The blade should be of ⅜-inch plate and not so deep that it will not pass easily over the lazy bar. Such a hoe will balance well, and is stiffest over the red-hot bed of the fire in "jumping" it during cleaning. The handle should terminate in a grip ring—something about right for an 11-inch hand, not your own.

The ash hoe may be broad and light, with a ¾-inch solid handle. It has not the heat of the fire to soften it, and the fireman has to lift its weight much more than that of the fire hoe, which is mostly carried by the lazy bar.

Costs of Pin Hole Grate Equipment

Below are the actual costs of the various components of a pin-hole-grate equipment for a set of four 250-horse-power boilers, including the fan-blast equipment:

Two fans, three-quarter housing, 48-inch inlet, 6x6-inch engine, $836.48.

Concrete setting, piping, etc., as per plan, $241.58.

Flue under boilers and damper doors, $152.16.

Total cost, $1,230.22.

Air Requirements and Grate Openings

For a 250-horse-power boiler the actual air consumption figures out as follows: Twelve pounds of air is required per pound of carbon or 16 pounds for coal with 15 per cent. ash. This air weighs 0.076 pound per cubic foot at 60 degrees Fahrenheit, so that one pound of coal will take 210 cubic feet of air; 250 horse-power, at 4½ pounds of coal per horse-power-hour, equals 1125 pounds of coal per hour, or 18.75 pounds per minute; 18.75 pounds per minute multiplied by 210 equals 3937 cubic feet of air required per boiler, or 63,000 cubic feet per minute for 16 boilers. At 2-inch air pressure, this will take two 40-inch fans, and 1256 square inches of flue area for eight boilers, or 1.09 square feet per boiler. As the grates are 8x8 feet, or 64 square feet,

$$\frac{1.09}{64} = 1.7$$

per cent. grate openings required. Assuming that fully one-half these pin holes will be blocked by the coal, 3.4 per cent. of pin-hole openings will probably be sufficient for complete combustion.

This figure is being borne out by the remarkable performance of numerous boiler plants where the 5 and 6 per cent. bars have been replaced by 3 per cent. bars; with a resulting gain of over 10 per cent. in evaporation. The experience with these plants has been that too much pin-hole opening has the same chilling effect as too frequently opened doors in a natural-draft boiler. The whole matter boils down to the quality of firemen obtainable. If good men are plentiful and the fires can be carried four to five inches deep, fired light and often and cleaned frequently, then the 3 per cent. bar will give the best evaporation. If the men are inexperienced and not able to do much more than shovel the coal in reasonably evenly, then a 6- or 8-inch fire with 5 per cent. bars will give the best all-around evaporation.

Machine Tool Trade Opportunities in Brazil

By M. de. Moreira

A great many American tool manufacturers are ignorant of the fact that Brazil is a progressive country where their goods will find a ready market. Unfortunately, now nearly all the machine tools there are of an antiquated pattern and mostly of German and English origin. In spite of this fact, it is nevertheless true that the Brazilians would rather favor American manufactures, as they seem to feel a kindred spirit for nations of the same hemisphere and also because American tools are more perfected.

Railroad Shops

The prevailing idea among American manufacturers is that there is no opportunity in South America for them. A few facts will convince them of the contrary: The Central railway, of Brazil, is building now all its cars. That line, owned by the government, is most important and possesses 305 locomotives. It runs from Rio to Sao Paulo and to Minas, and has all along its route well-equipped repair shops. Its buildings and shops, though not large, are up-to-date, and the government is increasing the amount of its machinery every day. The same thing can be said of the Nogyana railway, which has its own car factories; the Leopoldina railway, which operates 1423 miles of road, is constantly adding to its rolling stock, not by importation, but by home manufacturing.

Within the past year American interests, supported in a greater part by Canadian and French capital, have secured more or less perfect control of a system of rail and water transportation forming a belt line about the whole of the better portion of Brazil. This system, with the government lines and the government subsidized steamers, reaches nearly every portion of that great republic. This great system is composed of the Sao Paulo-Rio Grande railroad lines, the Amazon-Bolivian system and the Paraguay-Bolivian connections. The first reaches the coffee and the livestock districts and connects them with the seaboard. The second connects Bolivia with the Atlantic by means of the Bolivian railways and rivers. The third connects the coast system with the Paraguayan railroad, thus reaching into Bolivia and thence into the valley country of south-central Brazil.

Shipbuilding Plants

Regarding marine transportation, docks are now built in Rio, doing away with the necessity for steamers to anchor down the bay. We have read a few days ago of the great number of men-of-war ordered by Brazil in Germany and England. The newspapers have found in this fact a great political move, whereas any one familiar with South American matters understands very well the stand of Brazil in the matter of South American predominancy. Argentina and Brazil have never been very good friends and it is only natural for Brazil to try its best to be the sea-ruling power among South American republics. Ship building exists in Brazil on a larger scale than in any other South American republic. M. A. Lage has on the Ilha do Vianna very well equipped shipyards where big launches, coasters and even men-of-war are built, and the government has in all the ports arsenals and large repair shops, and naturally needs tools that can be supplied from American manufacturers.

In connection with this the government in Brazil has just made arrangements for the construction of the largest dry dock in South America. By the plans finally adopted, 100,000 cubic meters of rock will be excavated from the bottom, sides and land end, until the dock will have a total inside length great enough to admit a vessel 815 feet long. It will be divided into three sections, one of 150 meters, one of 70 meters and the third of 30 meters, so that three vessels of proper size can be handled at the same time. The dock is to be fitted with all the latest appliances and will afford necessary conveniences for the docking and repairing of vessels up to 16,000 tons.

Street-car companies in Rio de Janeiro and in Sao Paulo have their own car-building shops and a great part of the street cars used in the provincial towns are furnished from these shops.

Steel structures are also becoming popular in Brazil, especially in the port towns. With the enlargement of the streets of Rio de Janeiro, the modern buildings erected now have nearly all steel structures; however, what steel is imported comes almost entirely from Belgian and German houses. Have Americans any fear to compete with these two nations?

Foundries and Machine Shops

There are a great number of foundries and machine shops in Brazil; factories of different kinds are numerous considering

not the territory but the population; the official statistics give the number of 2397 factories in Brazil having a capital invested of $163,349,000.

The province of Rio Grande manufactures iron safes, stoves and other iron-foundry products. We all know that America manufactures the best safes in the world; still, looking over the safe export to Brazil during 1906, we see that out of $74,000 of safe imports during that year, America figures in the great sum of $2000; the rest is distributed between France, England and Belgium.

The province of Sao Paulo needs agricultural implements and tools for manufacturing and repairing them; the province of Minas requires dredging and mining machinery for its diamond mines, which are increasing in value every day. Are we not able to furnish these?

Icemaking Plants

Ice, a thing of absolute necessity, is another manufacture that could be picked up by the tongs, if the American manufacturer would only think of it. Let me quote you a passage of the report of our American consul in Brazil: "With the exception of a sailing ship's cargo of ice and apples received at Rio de Janerio once a year, at Christmas time, the ice supply of that city is altogether artificial, and the price charged for the product is very high as compared with the cost of the manufacture. Artificial ice in Rio de Janeiro for public use is supplied by a single factory, more or less out of date in its equipment. The ice, which is of low cooling power, is distributed mostly to depots in corner groceries and thence sold in small quantities to consumers at about 2½ American cents per pound."

Fiber weaving also needs our attention, as a great quantity of machinery and tools are required to produce a satisfactory result for export.

All that I have said should make the American manufacturer think seriously and realize the great opportunity he has ignored and is ignoring.

America should Arrange to Grant Credits

One of the chief stumbling blocks in the extension of the American export trade in this country has been an indisposition on the part of American exporters to grant credits, due to the fact that American manufacturers have preferred to do business upon a cash basis with a lower margin of profit than upon a credit basis with a larger one. The extent of this change in the past year is illustrated in the statements of the foreign banks in Rio de Janeiro at the end of February, 1906, as compared with February, 1907. There was an increase in the amount of bills discounted of about $2,110,500; in bills receivable, of about $2,626,800; in bills and securities pledged, of about $2,825,700.

The present general method followed by most Brazilian houses is to buy on, say, six months' time, with interest at, say, 10 per cent. from date of invoice. The jobber who thus purchases sells to the retailer on, say, three months' credit. The retailer sells for cash or arranges so that he can pay his bills at the end of the three months' credit. Thus the jobber and retailer do business with less capital than if their transactions were for cash. So long as interest charges in banks are higher than the rate of interest charged by the manufacturer or exporter on the original sale, this lack of capital has best been met by this credit system.

When banks loan money for the same rate as or less than the manufacturers or exporters, it pays to discount bills and pay cash or take short-term credits. What change there has been in buying methods indicated in the bank reports referred to is likely to have been more in the direction of using the banks, in place of the manufacturers or exporters, than in the way of any material change in financial conditions generally.

Catechism of Electricity

726. *How large is it customary to build switchboards equipped for two or more compound-wound dynamos?*

In large power stations, fifty to seventy-five panels are sometimes combined in one board.

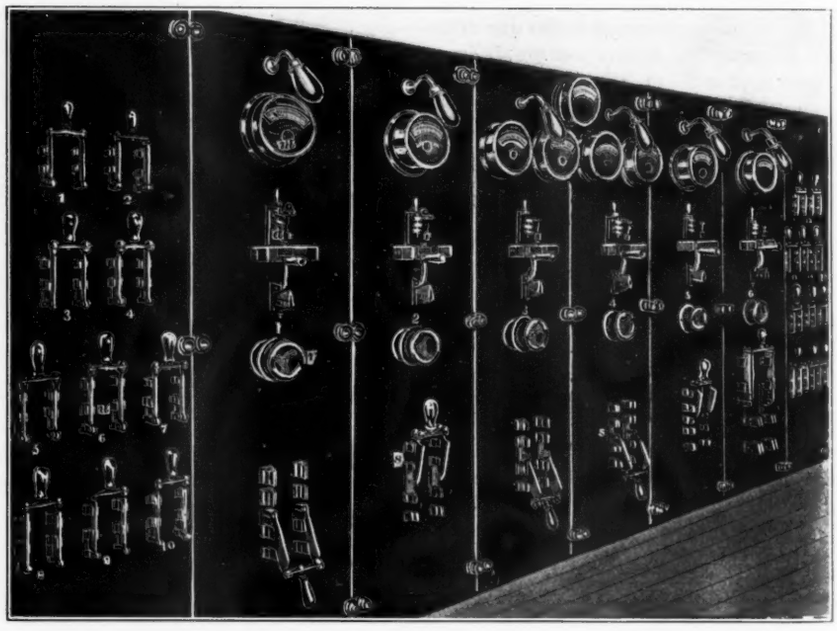


FIG. 249. SWITCHBOARD, COMPOSED OF SIX GENERATOR PANELS, EQUIPPED TO SUPPLY THE FEEDER CIRCUITS WITH CURRENT FROM AN AUXILIARY SOURCE IN CASE OF EMERGENCY

727. *How is the equipment of a switchboard arranged when provision is made for supplying the feeder circuits with current from an auxiliary source for use in cases of emergency?*

It may be arranged as in Fig. 249, which shows an eight-panel switchboard equipped for six generators. When the double-pole, double-throw main switches at *s*, *s*, etc., are closed upward, these machines are connected to the feeder circuit. At *m*,

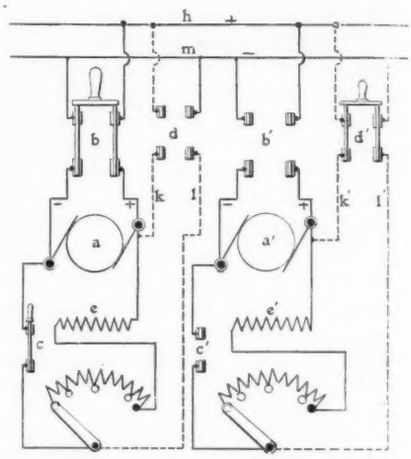


FIG. 250. DIAGRAM OF CONNECTIONS FOR ALLOWING DYNAMOS TO BE TEMPORARILY EXCITED FROM THE BUS-BARS

a and *r* on the panels are shown respectively the measuring instruments, circuit-breakers, and the hand-wheels of the rheostats in the generator field circuits. The switches controlling the feeder circuits are on the two end panels at *u* and *v* respectively. In case of accident to any one of the six generators, the current from the street-service wires can be instantly thrown on the feeder circuits by closing any one of the switches at *s*, *s*, etc., in the lower set of jaws.

728. *How should a switchboard be arranged for allowing any of the dynamos in the plant to be excited from the bus-*

bars, in case some of them become demagnetized or will not build up readily?

The switchboard equipment and wiring in this case should follow a plan such as that shown in Fig. 250. The bus-bars *h* and *m* are supplied with electricity by one or more of the dynamos *a* in the plant. Suppose the dynamo *a'* should have difficulty in building up when started. By closing the switch *d'* in the auxiliary circuit *k' l'* the full pressure on the bus-bars will be applied to the field winding *e'*, the current passing through the wires represented by dotted lines. When the voltage of the dynamo *a'* has come up to its normal value, and the switch *b'* has been closed, the switch *c'* may be closed and

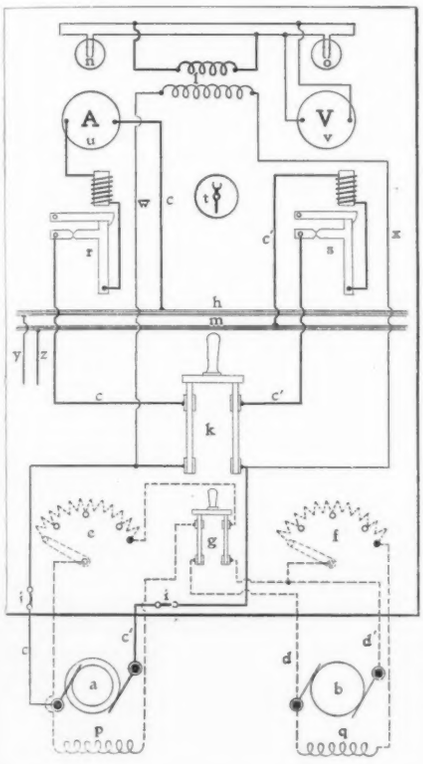


FIG. 251. SWITCHBOARD WIRING FOR A SINGLE-PHASE ALTERNATOR AND ITS EXCITER

d' opened, as shown for the dynamo *a*.

Each dynamo in the plant may advantageously be connected in this manner. It will be noticed that the auxiliary circuits of the dynamos *a* and *a'* include the field-circuit rheostat. If these were connected between the rheostat and the field winding, it would not be possible to regulate the voltage of the machine while the switch *d* or *d'* was closed.

Switchboard Wiring and Equipment for Alternating-current Dynamos

729. *Does the switchboard wiring for alternating-current dynamos follow any general plan, or does the wiring differ for each particular case?*

Each case generally has some feature peculiar to itself, but the principles in general are the same in all cases. One arrangement of switchboard wiring for a single-phase alternator is illustrated in Fig. 251. Here *a* is the alternator and *b* is the exciter; the field windings of these machines are indicated by *p* and *q*, respectively; the direct-current conductors are represented by dotted lines, and the solid lines represent wires that conduct alternating current. The field magnet of the alternator is excited by current from the dynamo *b*, carried by the wires *d* and *d'*, which terminate at the lower terminals of the double-pole switch *g*; the upper terminals of this switch are connected with the field winding *p* and the rheostat *e*. The rheostat *f* is connected in the field-winding circuit of the exciter *b*, and is used to regulate the voltage of the exciting current.

730. *Why are some of the wires represented by heavy and some by light lines?*

The main wires from the alternator are represented by heavy lines and are identified by the letters *c* and *c'*; they are connected through the fuses *j* and *i*, to the lower terminals of the double-pole switch *k*; from the upper terminals of this switch, wires run to the single-pole circuit breakers *r* and *s*. From here *c'* runs to the bus-bar *m*, and *c* is led to the bus-bar *h* after passing the ammeter *u*. Outgoing circuits may be connected to the bus-bars *h* and *m*; if there are two or more outgoing circuits, each should be provided with a switch, which may be located on the switchboard at either side of the main switch *k*.

731. *What are the coils indicated at l?*

The dynamo *a* is usually of too high a voltage to have lamps connected directly to its mains; a small transformer *l* is provided therefore, and it is located behind the board. The primary terminals of the transformer are connected to the alternator leads *c* and *c'* by the wires *w* and *x*; these wires must be connected to the lower terminals of the switch *k* so that the transformer will not be disconnected when the switch is open. To the secondary winding of the transformer are connected the pilot lamps *n* and *o*, and the voltmeter *v*. At *t* is a ground detector, which may be of any class suitable for alternating currents and the voltage of the circuit to which it is connected. The connections of this detector are not shown, because they depend upon the style of instrument adopted.

732. *Why are safety fuses and circuit-breakers both used?*

Fuses are connected between the alternator and the main switch, in order that they may protect the machine regardless of the position of the main switch blades. Circuit-breakers are seldom used when the voltage is above 3000, but for low voltages they may be used to good advantage beyond the main switch to protect promptly against external short-circuits. They should be of the single-pole type to prevent a short-circuit from the arc that occurs when the circuit-breaker operates.

Oil Fuel for Ships

Consul John L. Griffiths makes the following report from Liverpool on the extending utilization of petroleum for ship propulsion:

The use of oil as fuel has engaged the attention of the British admiralty for some time, and it has recently been decided to establish oil-storage tanks in various parts of the United Kingdom to insure convenient sources of supply. Birkenhead, directly opposite Liverpool, has been selected as one of the supply centers. The experiments conducted by the admiralty during the past twelve years were not at first satisfactory, and two adverse reports were made prior to 1902. Since then the tests have been of such a character as to reverse the original judgment of the admiralty, and it may now be said that the importance of oil fuel is recognized by that body.

It is claimed that through the use of oil the number of men now required to do the stoking and trimming would be reduced by two-thirds, as the moving and stoking of the oil is automatically accomplished by steam pumps and pipes, instead of by stokers and trimmers as in the case of coal.

Advantages of Oil Over Coal

The oil, it is suggested, could be stored in the double bottom, now taken up by water ballast. In the case of the navy, one of the great advantages claimed for oil is the absence of a great volume of black smoke when vessels are proceeding at great speed, and which serves to give information to the enemy. The evaporative value of oil is much greater than that of coal, so that while 45 cubic feet of bunker space is required for a ton of coal, only 38 cubic feet is needed for a ton of oil. It will readily be seen how significant this difference would be to the great ocean-going steamers, and how much space now set apart in them for the storage of coal would be released for cargo purposes and passenger accommodation.

The British navy has in service oil-using torpedo boats with a capacity of 34 knots. One of the drawbacks at the present time to the extensive use of oil fuel at sea is the high cost and the difficulty in many instances of securing it. The cost of oil in Great Britain has no doubt seriously interfered with its adoption for steamships and for a variety of industrial purposes. With a reduction in price the field for its employment would be greatly enlarged. The advantages of oil fuel briefly summarized are economy of space, absence of soot and cinders, elimination of the loss of time consumed in burning down and clearing fires when coal is used, the ease with which oil can be bunkered, and the quickness with which a full head of steam can be generated.—*Monthly Consular and Trade Reports.*

The Operation of Electrical Machinery

Suggestions to Be Followed when Installing a New Plant, with Special Regard to Location of Apparatus and Operating the Generators

BY NORMAN G. MEADE

General Suggestions

The following general suggestions will be found worthy of consideration when a new plant is installed:

When the location of a machine is determined, it should be chosen so that the machine will not be exposed to moisture, as from dripping pipes or escaping steam; it should not be exposed to dirt or dust, from coal handling or other causes; it should be placed in as cool and well-ventilated a place as possible. This latter requisite is important for the reason that a well-ventilated machine will carry heavier loads and deteriorate less than one less favorably located.

All machines should be set on substantial foundations, in order to prevent vibration when running. Solid masonry is best for a foundation, but a framework of timber may be used for machines that are well balanced.

It is well to keep the iron of a low-tension machine insulated from the ground, and to this end the bolts securing the machine to its foundation should not come in contact with any other metal or electric conductor. The supports under the machine should be covered with an insulating waterproof paint or compound.

When setting a belt-driven machine upon its foundation, it should be carefully leveled and the pulley accurately lined up with the driving pulley. In erecting large machines, first get the lower half of the field-magnet into position, then place the armature shaft in its bearings, and after that put on the upper half of the field-magnet. In bolting the upper and lower halves of the field-magnet together, all dirt should be brushed off the surfaces in order that the contact may be close as possible; otherwise there may be an unnecessary weakening of the field magnetism.

The weight of an armature should never be supported to any degree by the commutator, nor should the commutator be allowed to rest on any blocking. When handling the armature, it should always be supported by a rope sling about the shaft, and the workmen should be very careful not to mar or scratch the shaft, as any roughness would cause it to cut the bearings and cause heating.

To Operate a Single Generator

See that the oil gages show the proper amount of oil in the bearings and that the tension of the brushes is correct for good contact. Start slowly and see that the oil rings are revolving freely, then get the machine up to speed. Raise the voltage to the proper point by cutting out resistance with the hand regulator. After this is done, throw in the circuit-breaker and finally close the main switch.

Give the brushes as much forward lead as possible, when generating the full rated voltage at no load, and secure the quadrant at that point; that is the best position for operation with fixed brushes.

To shut down the machine, throw out the circuit-breaker, and then open the generator switches; afterward cut in all the resistance of the field rheostat. Then stop the machine and clean it, ready for another run.

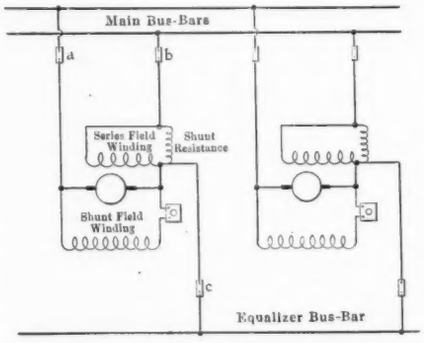


FIG. 1. SHOWING THE EQUALIZER CONNECTIONS

Operating Generators in Multiple

To operate compound-wound generators in parallel it is necessary, in order to have each one work in proportion to its capacity, to connect them in three places: At the main terminals of each machine; at the junction of the series winding, and the brushes to which it connects. The connection from the junction of the series winding and brushes is called the equalizer wire, and extends to an equalizer switch, as shown in Fig. 1.

If the generators are of the same size and make, the only point requiring special attention is that the wires which run from the different machines to the equalizer bus-bar or switches must be of the same resistance, as well as the main lead wires. If the generators differ in design or size the matter becomes more complicated. In this case the difference of potential or drop in voltage between the junction of the series winding with one of the brush cables and the bus-bar to which the other end of the same series winding is connected should be exactly the same for every generator when each is carrying its proper share of the load. To make this drop the same for each generator, it will be necessary to put resistance in circuit with the series coils of the one showing the least "drop." The equalizer wires must show as little "drop" as possible, and never more than the generator leads.

Large machines require several hours for their field-magnet coils to attain a constant temperature; and as the coils heat up, it becomes necessary to cut resistance out of the shunt-field circuit.

To operate three-wire generators in multiple, two equalizer wires are necessary; one extends from the positive and one from the negative commutator brushes. The balancing coils are usually connected to the collector rings through switches, the neutral wire being taken to the switchboard. It is unnecessary to connect the alternating-current leads from the armatures in parallel, nor is it necessary to consider the periodicity of the alternating currents generated by the different machines. Three-wire machines may be operated together irrespective of the number of poles and speed of each, just as easily and simply as two-wire generators. Two- and three-wire generators may also be run in multiple with each other. In large stations with many units it is therefore practical to operate one three-wire generator, provided it has sufficient capacity to carry the difference between the loads on the two sides of the system; all other machines may be of the ordinary single-voltage type. It is, however, advisable to install duplicate three-wire units, each of sufficient capacity to provide for the maximum unbalanced condition of the system.

The switchboard for a three-wire generator is similar to that used with the ordinary system, except that an additional equalizer bus-bar must be provided. It is usually advisable to provide ammeters in both the positive and negative generator leads. The connections of two- and three-wire generators operating in multiple are shown in Fig. 2. The arrangement by which the two sides of the system may be closely balanced is indicated by reference to Fig. 3.

Starting Direct-current Generators Operating in Multiple

If there is one generator *A* furnishing

current to the line, and it is desired to throw in another one *B* on the same circuit, the following procedure should be carried out: (1) Get *B* up to full speed; (2) adjust the voltage of *B* as nearly as possible to equality with that of *A*; (3) close the equalizer switch, and then the main switches; (4) notice the ammeters to see that the loads are rightly proportioned; if the dynamo *A* is doing more than its share of work, throw resistance in with its regulator or out with the regulator of the dynamo *B*, but if *B* is doing too much work, adjust the regulator oppositely. Succeeding machines are thrown in similarly.

If a generator is thrown in multiple with another one before its voltage is up to equality, it will not do its share of the work and may even run as a motor, taking current from the other machine. In such a case, throw resistance out with the regulator of the machine which has just been put on the circuit. When two machines are working together, if the belt on one of them should break, or slip off, the machine will continue to run, being driven as a motor by current from its mate.

that the shunt-field circuit of the generator is not opened or broken while it is working in multiple with another one. In case this should happen, the armature and series winding of one or both machines would be damaged unless they were instantly cut apart by the opening of the circuit-breakers. If it becomes necessary to raise or lower the voltage of the lines,

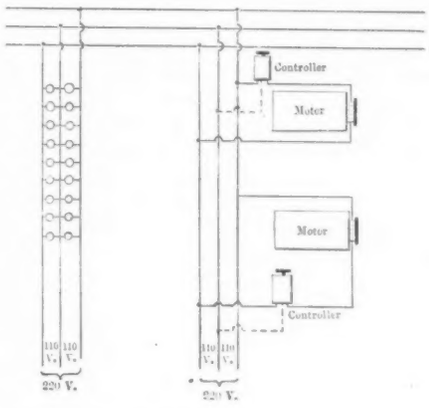


FIG. 3. SHOWING HOW THE TWO SIDES OF THE SYSTEM MAY BE CLOSELY BALANCED

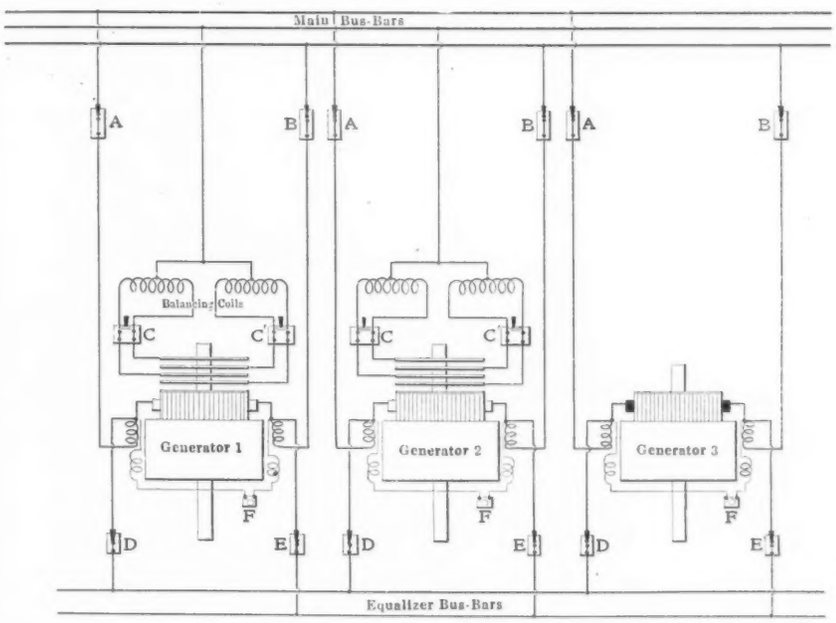


FIG. 2. CONNECTIONS OF TWO- AND THREE-WIRE GENERATORS OPERATING IN MULTIPLE

If two machines do not operate together satisfactorily, note the position of the brushes. If one of the machines carries too much of the load, move its brushes slightly forward, if it can be done without causing them to spark.

Stopping Direct Generators Operating in Multiple

Cut out resistance with the regulator of the generator to be shut down, until the ammeter shows a very small load; then open the circuit-breaker, and finally, the generator switches. Be very careful all machines which are supplying the current must be adjusted to that end.

General Instructions

Machines must always be kept dry; any moisture on the commutator or armature will cause trouble. Keep machines clean and free from oil and dirt; carbon dust must be cleaned off frequently. Be especially careful to see that no oil or dirt collects about the brush-holders or the commutator. Keep all small pieces of iron, such as bolts, nuts, etc., away from the machines.

Fuels of the United States *

By Prof. N. W. Lord

While technically this subject would include not only coal in its various varieties, but gas, oil, wood, peat and possibly other substances, I shall confine what I have to say to coal. Six classes of coal are recognized by the United States Geological Survey: (1) Anthracite, (2) semi-anthracite, (3) semi-bituminous, (4) bituminous, (5) sub-bituminous or black lignite, and (6) lignite. I think it safe to say, however, that while this classification is generally useful, it is difficult to draw fast and sharp lines in the classification of a material as variable as coal, in which samples are sure to be found on the border lines of almost any system of classification. The above classification, of course, is only for commercial purposes, and, as such, is generally useful. In a valuable map prepared by M. R. Campbell and recently published by the United States Geological Survey, the coal areas of the United States are carefully mapped. In this map the coals are grouped (a) as high-grade coals, which include classes 1, 2, 3 and 4, (b) sub-bituminous or black lignite, or class 5, and (c) lignite proper, or class 6. The general qualities of these types of fuel are known and correspond well to the coals of certain regions, as the anthracites of Pennsylvania, the coking bituminous coals of Pennsylvania, the non-coking bituminous coals of Ohio and Illinois. Coals differ widely not only in their physical characteristics, their behavior under a destructive distillation, some cementing together into a hard coke or possessing the coking property, as it is termed, others, the so-called dry coals, showing but little or none of this quality, but also in their chemical composition and in their associated impurities.

Proximate and Ultimate Analyses

As ordinarily made, the chemical analysis of coal, commonly known as the proximate analysis, is not in the strict sense of the word an analysis at all, but is merely a record of the nature of the decomposition that the coal undergoes when treated in a certain conventional manner. It involves the determination of the moisture or loss in weight when the coal is dried under certain specific conditions; of the volatile combustible matter or the material other than moisture which is driven off by heating the coal in a prescribed way in a platinum crucible; the fixed carbon, which is the loss in weight of the residue after driving out the volatile matter when the combustible matter is all burned out by heating in air; and, finally, the ash or combustible residue left from the foregoing treatment.

*Abstract of a paper read at the third convention of the International Association for the Prevention of Smoke, Cleveland, O., June 24, 25 and 26, 1908.

As contrasted with this, is the ultimate analysis of the coal in which the actual percentages of carbon, hydrogen, nitrogen, sulphur, oxygen and incombustible residue or ash are determined. This latter method of analysis is strictly a chemical analysis and determines definitely the substances present in the coal.

The heating value of a coal is the amount of heat expressed in British thermal units developed by the complete combustion of one pound of the coal, and for all purposes in which coal is used as a fuel is, of course, the fundamental factor on which the fuel value of the material is based. Table 1 gives the proximate and ultimate analyses and the heating value of a typical coal in each of the foregoing six classes. The following will locate and describe the coals given in the table:

Class 1—Anthracite, culm, Scranton, Penn.

Class 2—Semi-anthracite, Coalhill, Ark.

Class 3—Semi-bituminous, Mora, W. Va.

Class 4—Bituminous coking, near Connellsville, Penn.

Class 5—Bituminous non-coking, Ohio No. 6, Hocking Valley.

Class 6—Sub-bituminous, black lignite, Uinta County, Wyoming.

Class 7—Lignite, Milan County, Texas.

TABLE 1. COMPOSITION OF ILLUSTRATIVE COALS.

PROXIMATE ANALYSIS OF "AIR-DRIED" SAMPLE.

Class.	1	2	3	4	5	6	7
Moisture	2.08	1.28	0.65	0.97	7.55	8.68	9.88
Volume combustion	7.27	12.82	18.80	29.09	34.03	41.31	36.17
Fixed carbon	74.32	73.69	75.92	60.85	52.57	46.49	43.65
Ash	16.33	12.21	4.63	9.09	5.85	3.52	10.30
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Loss in air-drying	3.40	1.10	1.10	4.20	Undet.	11.30	23.50

ULTIMATE ANALYSIS OF COAL DRIED AT 105° C.

Hydrogen	2 63	3.63	4.54	4.57	5.06	5.31	4.47
Carbon	76.86	78.32	86.47	77.10	75.82	73.31	64.84
Oxygen	2.27	2.25	2.68	6.67	10.47	15.72	16.52
Nitrogen	0.82	1.41	1.08	1.58	1.50	1.21	1.30
Sulphur	0.78	2.03	0.57	0.90	0.82	0.60	1.44
Ash	16.64	12.36	4.66	9.18	6.33	3.85	11.43
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

CALORIFIC VALUE OF "AIR-DRIED" COAL IN B.T.U.

	12,472	13,406	15,190	13,951	12,510	11,620	10,288

These analyses were, with the exception of No. 5, made upon samples taken from carload lots shipped to the Government fuel-testing plant at St. Louis. The analysis No. 5 is a sample of Hocking coal taken at the time by field agents of the Ohio Geological Survey. It will readily be seen that there is a progressive change, consisting of a decrease in the fixed carbon and increase in the volatile matter, and in the ultimate analysis, an increase in the amount of oxygen and hydrogen. It is interesting to note that the maximum heating value of these coals rests with the semi-bituminous coals of the Pocahontas type, high in fixed carbon and comparatively low in volatile matter. The amount of moisture increases with the type of coal, but only in a very general way. It will be noted that the coals are reported in most cases as air-dried. Coals freshly mined contain considerable water, which is rapidly lost on exposure to air. The analyses are reported upon the coal in approximately the condition of moisture to which it will attain upon standing exposed to the ordinary air, the coal being in a coarsely crushed condition. If the coal be reported as made up of three main constituents: Moisture, the combustible portion or true coal, and lastly ash, and the typical analyses of the various groups may be corrected by eliminating by calculation the amount of moisture and ash and restating the composition of the remainder considered as coal. This is done in Table 2.

TABLE 2. RESULTS IN TABLE 1 CALCULATED TO ASH AND MOISTURE FREE BASIS.

PROXIMATE ANALYSIS.

Class.	1	2	3	4	5	6	7
Volatile combustion	8.91	14.82	19.85	32.34	39.30	47.05	45.31
Fixed carbon	91.09	85.18	80.15	67.66	60.70	52.95	54.69
	100 00	100.00	100.00	100.00	100.00	100.00	100.00

ULTIMATE ANALYSIS

Hydrogen	3.16	4.14	4.76	5.03	5.41	5.50	5.05
Carbon	92.20	89.36	90.70	84.89	80.93	76.35	73.21
Oxygen	2.72	2.57	2.81	7.34	11.18	16.28	18.65
Nitrogen	0.98	1.61	1.13	1.74	1.61	1.25	1.47
Sulphur	0.94	2.32	0.60	1.00	0.87	0.62	1.62
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

CALORIFIC VALUE IN B.T.U.

	15,281	15,496	16,744	15,512	14,446	13,203	12,889

With the analyses given as in Table 2 the progressive changes in the composition of the material become much more apparent and uniform, particularly the progressive increase in volatile matter and decrease in fixed carbon. Here, again, it will be noted that the heating value of the combustible portion is highest in the semi-bituminous, class 3.

The sulphur in the coal may also be regarded as one of its impurities, though in many cases a considerable portion of it, if not most of it, must be considered as in fact an inherent part of the coal proper, only a portion of it existing as iron pyrites. In many coals, on the contrary, a large percentage of the sulphur present is simply mechanically mixed pyrites. It is this uncertainty in regard to the disposition of the sulphur which makes such calculations as are exhibited in the tables only approximate. In these results it should always be remembered that in ultimate analyses of coal the oxygen determined cannot be considered as more than approximately correct, being determined by difference and the results modified by the condition in which the sulphur exists. The foregoing outline serves to show that the coal from any district or mine may be considered as made up of coal proper and a certain amount of mechanically held impurities, consisting of ash, moisture and sulphur in the form of pyrites.

VARIATIONS IN SULPHUR, ASH AND MOISTURE

One of the results of the investigation of the fuels of the country has been to show that the character of the coal proper is much less subject to variation in the mines of a given seam in a given district than are the relative proportions of the impurities, particularly ash and sulphur, which vary greatly in different portions of the same seam and frequently vary considerably from one portion of a field to the other. A very interesting example of this is found in the Middle Kittanning, or No. 6 coal, of the Ohio series, in which the sulphur in certain portions of the seam covering areas of many square miles in extent will run under 1 per cent., the amount increasing, however, as the seam extends northward until regions are reached where for the

same coal the average sulphur content is over 5 per cent.

Variations in the ash take place in the same way, but without so much regularity. Yet throughout the entire extent of this district the variation in the ultimate composition of the actual coal itself is not material. The amount of moisture in coal is a matter of considerable regularity and the power of the fuel to hold moisture seems to be closely connected with its general ultimate composition and nature of the seam. This, of course, refers to the moisture retained by the coal under ordinary conditions of handling. The effects of these impurities upon the quality of the coal are of two general kinds: Those acting as diluents or worthless admixtures reducing, in proportion to the amount, the heating value of the coal of which they form a part.

Sulphur cannot strictly be regarded in this light, as it stands for a heating value of its own equal to approximately half of the coal that it replaces. Moisture, on the contrary, not only reduces the heating value of the coal as a diluent, but absorbs appreciable quantities of heat in its evaporation. Its presence in the coal bears unquestionably a relation of some importance to the nature of the combustion, and probably bears to some extent on the problems of smoke consumption, as it is probable that moisture in the gas of a furnace has a certain power of facilitating the completeness of combustion. In addition to the effect of these materials as diluents, their positively injurious characters must be considered in many operations, as that of sulphur in the manufacture of iron and gas and the clinkering power of ash in obstructing drafts and leading to increased cost and diminished efficiency in the handling of the fuel.

Geological Survey Tests of Great Importance

It is difficult to state in dollars and cents the relative importance of these impurities, but under the recent system of coal purchased by the Government, a fairly satisfactory system of figuring coal on analysis with reference to its impurities has been put into successful operation. During the last three or four years the fuel-testing plant of the United States Geological Survey has been accumulating and publishing one of the most extended series of the complete analysis of the fuels of the country that has ever been undertaken anywhere. One point of interest in this work is that the analyses have all been made on large and carefully taken samples representing the average character of the coal shipped from the mine tested, such samples being designated as carload samples and prepared by careful reduction from shipments of coal covering several tons in all cases. The analyses published give illustrative determinations on almost every important coal district in the United States, and, properly used, will enable coal users to arrive at very satisfactory conclusions in regard to the properties of any coal on the market. However, in the use of these analyses the principles outlined in the foregoing discussion must be constantly kept in view. The general character of the combustible portion of the coal from any district may be considered as agreeing quite closely in all samples from the same district, providing the geological designation of the seam is known to be that given by the sample reported in the survey report. The variations shown in samples from the same mine in regard to ash, sulphur and moisture show very clearly that these items can only be judged in a general way as applying to particular samples of the coal and, therefore, would in no wise diminish the necessity of tests on any particular coal for its ash, moisture and sulphur contents. Similarly, the heating value given will vary with the percentage of impurities, and it will be possible to judge what the average character of the coal from a given district should be, and so set an approximate standard for users of the coal to which shipment of any particular lot may be referred on the determination of the ash, moisture and sulphur.

The use of the ultimate analysis of the coals in figuring up the results of tests on boilers and other efficiency tests can be extended widely by applying the ultimate analyses published in the Government report of similar coals, after making due allowance for the ash, moisture and sulphur considered as the impurities. In most cases calculations of this kind will give results amply accurate for use on ordinary control, when it is necessary to calculate the air required to burn the fuel or similar data of combustion.

Of particular interest to the association for the prevention of smoke is the variations of the different coals in the nature and character of the volatile matter given off on heating. It is well known that different coals differ in their smoke producing tendencies. Within the last two years a series of important investigations on the destructive distillation of coal has been carried on by Dr. H. C. Porter in the laboratory of the technologic branch of the United States Geological Survey, in which it has been shown that coals differ very considerably in the nature of the volatile products distilled at low temperatures and in the early stages of heating. These differences correspond to different degrees of combustibility in the liberated gases. The work has also shown differences in the rate at which these volatile materials are expelled from different coals and also in the percentage of inert or non-combustible material present in the gases evolved. Time has not permitted the extension of these investigations to more than a few typical coals, but the results so far obtained indicate that the investigations will prove of great value to the engineer in solving the important problems of specializing furnace design to burn, with the greatest advantage and with the least production of smoke, particular types and classes of coals. The results will probably also be valuable in the important study of the details of methods of firing and handling the coals with reference to the nature and combustibility of the volatile material.

A Backwoods Repair Job

It was a country plant and the owner was an all-around tinker; so when one of his men declared that he had to have a new cylinder lubricator, he asked:

"What's the matter with the old one?"

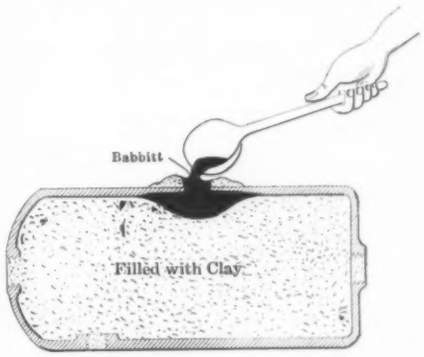
"Busted."

"Mend it."

"Have. It won't hold."

"Bring it in."

The cup was brought and certainly looked to be all in. The core had shifted when the pot was cast, and one side was so thin that it had burst through, making quite a large opening from which ran cracks up and down the cylinder.



REPAIRING THE LUBRICATOR CUP

The backwoods genius proceeded to plug the cup full of clay, which he scooped from the road bank opposite, and then to dig out through the bursted place enough to make a cavity behind all the weak and injured portion. A ladleful of melted babbitt was poured into this cavity, forming a button over the fracture inside the cup. The spew was hack-sawed off and smoothed away with a file, the clay removed, the "inwards" put back and the cup went to work again with all its original efficiency, and apparently good for a long period of service.

The trustees of the University of Illinois recently awarded the contract for a new building for its College of Engineering, to be occupied wholly by the department of physics. The structure is to cost, with its equipment, $250,000. It is to be erected just east of the present engineering building, and is to be known as the "physics building."

New Gas-Electric Power Plant at Gary, Ind.

Description of Engines in What Is to Be the Largest Power Station in the World, in Which Seventeen Gas-Engine-Electric Units Are Being Installed

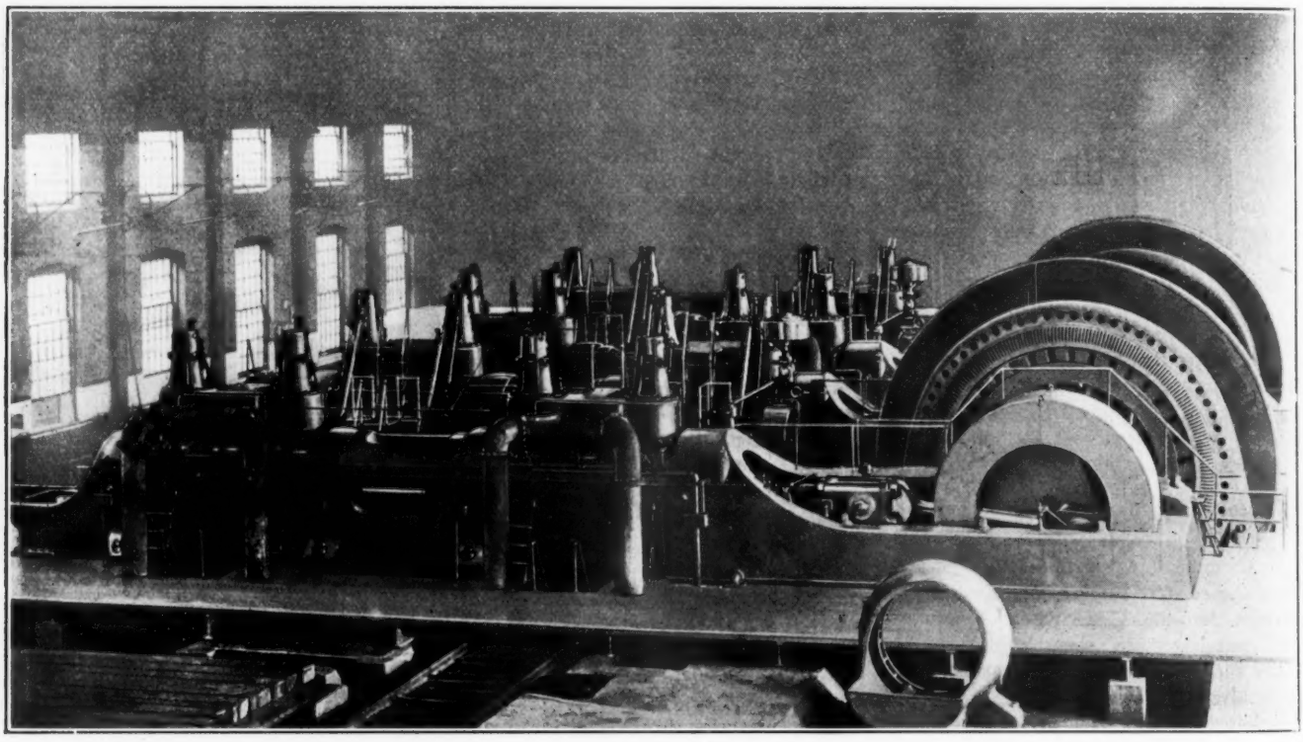
BY CLAUDE AIKENS

The "electrification" of the plants of the United States Steel Corporation, which has been in progress for some time past, will soon reach its climax in the completion of the new works at Gary, Ind., where the huge gas-engine-electric generating units are now being erected in the mammoth structure built for their accommodation. While, as yet, illustrations are not available, a general idea of the character and size of the seventeen engines and generators to be installed there, with sixteen gas-engine-driven blowers of like dimensions, may be gained from the photograph reproduced herewith showing two such units recently put in operation, and parts of two others now being erected, in another of the steel corporation's plants, namely, the South Works of the Illinois Steel Company, at South Chicago, Ill. At Gary, the bed-plates and frames have been placed and some of the alternating-current generators are completely assembled, but there is still much to be done before the plant begins to take shape as a working unit.

When completed, this will be the largest power station in the world. The power house, which is 966 feet long and 105 feet wide, with forty-two 23-foot bays, will be located immediately adjacent to the two blowing-engine houses and between the blast furnaces and the open-hearth furnaces. In this central station will be installed seventeen horizontal, twin-tandem double-acting Allis-Chalmers gas engines, turning at a speed of 83⅓ revolutions per minute, fifteen of which are designed for coupling to alternating-current generators and two to be connected to direct-current generators. The former are 25-cycle, three-phase, 2300-volt machines, and the latter deliver current at a pressure of 250 volts. The engines have a rating of 4000 horse-power and the generators 2000 kilowatts, but the units are capable of carrying continuously 30 per cent. overload.

These are the largest engines in the world to operate on blast-furnace gas, being practically duplicates of the units built for the Illinois Steel Company, which are operated in parallel. Each of these engines, on blast-furnace gas of about 80 to 85 B.t.u., will give a safe maximum in the neighborhood of 4000 horse-power but will work up to approximately 5000 horse-power on the richer gases. The features of the engines which appeal most strongly to engineers who have seen them in service are the simplicity of design, the solidity of construction and the quiet operation. Maximum overloads are handled easily and with noticeable freedom from vibration.

While the engines are, as a whole, exceptionally rigid and heavy, the weight is concentrated in the frame cylinders and tie pieces in the direct line of stresses to which an engine of this type is subjected. The frame jaw, which is subjected to very severe stresses, is strengthened by two steel tie bolts above the shaft, which are made of sufficient size to carry their proportion of the load without appreciable elongation. The engine frames weigh approximately 90 tons each, and one-half of each frame is buried in the foundation, in order to raise the floor line to a point which will make the slides on the valve-gear readily accessible.



TYPE OF GAS ENGINES TO BE INSTALLED AT THE UNITED STATES STEEL CORPORATION'S PLANT AT GARY, IND.

The floor space occupied by one engine is 70 feet by 44 feet, and the weight approximates 1,700,000 pounds. The cylinders are 44 inches by 54 inches stroke, the crank pins are 20 inches in diameter, the shaft is 30 inches in diameter in the bearing, and the fly-wheel is 23 feet in diameter, weighing 200,000 pounds. The pistons and rods are water-cooled, water being introduced at the center and flowing forward to a discharge in the frame for the front piston and backward to a discharge in the tail guide for the rear piston, each piston having its separate supply. For dismantling or for cleaning, the rod is made in two parts joined at the central shoe, the rear half going out at the back of the engine and the other half going out through the frame, which is made open at the top for convenience.

The Valves and Valve-gear

The valve-gear is of the builders' standard "stratification" type and the engine operates with constant compression. The main inlet valve is of the single-beat poppet type opened by an eccentric and the usual linkage. The mixture of the air and gas is effected before entering the cylinder by means of an annular mixing chamber located under the main inlet bonnet; the operation of this is such that at the instant of closing of the main inlet valve there is practically no explosive mixture left outside the cylinder. The gas valve is of the double-beat poppet type controlled by a variable-lift rolling lever operated by a single-link connection to the main inlet gear, the lift of the valve (and consequently the amount of gas admitted) and the time of admission being regulated by the governor. The exhaust valve is of the single-beat poppet type opened by an eccentric, and is in this respect a duplicate of the main inlet gear. The exhaust bonnet is located at the bottom of the cylinder, and a substantial jack is provided to lower the entire exhaust mechanism out of place to allow inspection and regrinding of the valve, which also serves to swing the valve chamber, with the valve and its entire operating mechanism complete, out to one side where it can be reached by the crane hoist. The removal of one pin, either in the inlet or exhaust mechanism, is all that is necessary to allow the removal of either the inlet or exhaust bonnets, with their valves and entire operating mechanism, without disturbing any adjustment whatever.

The igniters are of the electromagnetic make-and-break type, so arranged that the time of ignition throughout each engine may be adjusted by a single hand-wheel. Direct current at 80 volts is used for the ignition. Duplicate independent igniters are provided at each end of each cylinder to insure prompt firing of the low-heat-value gases and also to avoid the danger of shutdown due to short-circuit.

The starting device consists of a small poppet air-inlet valve at each end of each cylinder, operated by the layshaft. Air is admitted to each cylinder in turn at what would be the working stroke. As the high compression of the engine prevents it from stopping on the dead center, this arrangement insures the prompt starting of even a tandem engine without the use of a barring gear.

All wearing surfaces, including the main bearings, slides, crank and crosshead pins, are supplied by a continuous oiling system and the cylinders are lubricated by timed admission of the cylinder oil, sight-feed oil pumps being used.

The alternating-current generators are of a type developed for use with these engines. The laminated stationary armature core is held in a heavy box yoke designed to allow full circulation of air around all parts. The core punchings are held in place by means of dovetails and the armature windings are placed in open slots in the inner periphery of the core. The coils are held in place by wedges and, on account of the open-slot construction, can be readily replaced in case of damage. The field-magnet poles are mounted on a cast-iron spider and so arranged that they can be removed; the exciting coils are of copper strip wound on edge.

The revolving field magnet is of special construction. The poles are of solid cast steel and are bolted to the spider; the field-magnet windings are held in place partly by the projecting pole-tips and partly by brass rings running completely around the magnet on each side and fastened to the tips of the poles by long brass screws. This construction, combined with the solid poles, gives a heavy damping effect, which opposes hunting and facilitates parallel operation.

The direct-current generators have also been designed with particular regard to this service but in general are similar to standard engine-type machines.

The power will be distributed throughout the works to operate heavy induction-motor-driven rolls, tilting and feed tables for the various passes, hot saws, hot and cold pull-ups, hot rolls, transfer tables, straightening machines, cold saws, elevators, conveyers, pumps and a multitude of machines and mechanical devices auxiliary to the operation of such an enormous plant. Two of the motors now being built are of 8000 horse-power each; they are designed for turning the rolls. From this the motors range in size down to machines of the smallest capacity used to operate switches in the power house.

All of this system will be subject to central control from a switchboard running the entire length of the main power plant and operated from a gallery 16 feet above the floor.

The Gas

When the works are in full operation, as at present laid out, there will be available for every hour a volume of gas drawn from the blast furnaces aggregating ten million cubic feet, or about a quarter of a billion cubic feet daily. From the furnace tops the gas passes first to large tanks or settlers, where the larger particles held in suspension gradually settle to the bottom. Then the gas is allowed to flow out at the top and through a pipe to the primary washer, a tank filled with water, which catches more of the impurities as the gas brushes its surface. The gas then rises again and is drawn off into a large supply pipe running the length of a row of hot stoves, where about 30 per cent. is diverted for use in heating them for the blast. The remainder flows directly to the power plant and 7 to 8 per cent. is burned under boilers to generate steam for the auxiliary steam engines, spare blowers, pumps, etc., and for use in heating.

The gas for the big engines then goes through another washer or scrubber, which consists essentially of a drum fitted with wings or paddles revolving inside of a cylindrical shield. As the gas flows between the drum and the shield, it comes in contact with a film of water spread on the inside of the shield by a suitable device; centrifugal force projects the remaining particles in the gas outward and presses them against the water film, which catches and holds them. The gas leaves the washer under pressure for the storage tanks, from which it is sent to the engines as required. In its journey from the tops of the blast furnaces the gas diminishes in volume about 2 to 2½ per cent., besides the quantities stated, and the blowing engines take 12½ to 15 per cent., leaving in the neighborhood of 42 to 45 per cent. available for the electric generating units.

The Blowing Engines

The blowing engines are housed in two plants adjacent to the power house, as above stated, each of which contains eight gas-engine-driven blowers and two steam-blowing engines; the latter are of standard furnace design. Eight of the blowing engines are of Westinghouse make and eight Allis-Chalmers. The steam blowers are Tod machines. Each of the sixteen blowing engines consists of a horizontal, twin-tandem gas engine of 3600 horse-power, having cylinders 42 inches bore and 54 inches stroke, and two direct-driven blowing tubs having a capacity of 30,000 cubic feet of free air per minute against a pressure of 18 pounds per square inch, and so designed and proportioned that they can be operated at any pressure up to 30 pounds.

All of the engines exhaust into conduits running along the side of each sta-

tion, with an equalizing tunnel in the center and a chimney 100 feet high by 9 feet in diameter at each end.

Some idea of the proportions of the Gary plant may be gained from the fact that it is expected to ultimately employ 15,000 to 20,000 men; the site covers 6000 acres lying on the shore of Lake Michigan, 26 miles east of Chicago, and the plant as now laid out will occupy approximately 1280 acres, or two square miles. It is estimated that it will handle not less than 5,000,000 tons of ore per year and produce annually approximately 2,500,000 tons of steel. There will be sixteen blast furnaces, of 450 tons daily capacity each, and eighty-four 60-ton basic open-hearth furnaces.

The line of improvement in electrical machinery which has probably done most to encourage its adoption in mill operation has been that of developing a high torque at starting. Rolls for handling plate, rails, etc., also require in most instances a motive power capable of speedy reversing, and all types of machinery used in steel plants demand enormous overload capacity. These conditions have all been met. Electric motors, as thus far tried, appear to have, in combination, possibilities which are far beyond anything achieved by the older methods of engine drive. In fact, the use of electric current has thus far found no limit in iron and steel works operations. It has conquered in one direction after another, and the success with which motors have been applied to the heaviest work, such as turning and reversing large blooming rolls, leaves no field untouched.

At Gary, with the enormous generating capacity available, at a veritable minimum of expense, there will be every incentive to extend the use of electric current, and applications now unthought of will be undoubtedly made, to the information and benefit of the industrial world at large. The progress and development of this plant will, therefore, be watched with great interest by engineers in every civilized country of the globe.

Tests of New Government Cruisers

Two or more years ago the United States Government contracted for three scout cruisers to be identical in all their characteristics, with the exception of the motive power. Each specification called for the hull to be 423 feet long and 47 feet beam, of 16 feet 9 inches draft and 3750 tons displacement, each vessel to be equipped with a steam unit of 16,000 horse-power capacity. An average speed of 22.5 knots for 24 hours was stipulated, at a fuel consumption of 1.8 knots per ton of coal, and a sustained speed for four hours of 24 knots per hour.

A contract was placed with the Bath Iron Works, Bath, Me., for one of these cruisers, specifying that she should be fitted with Parsons turbines. At the same time contracts were placed with the Fore River Shipbuilding Company, Quincy, Mass., for the other two cruisers, specifying that one should be equipped with triple-expansion engines and the other with Curtis turbines.

It was the desire of the engineer-in-chief of the navy as nearly as possible to arrive at a direct comparison with regard to the advantages and disadvantages of these three distinct types of prime mover. With this in view a test is to be conducted under the supervision of Government officials in the same water at the same time on all three vessels, each of which is to be supplied with coal of the same quality, and the race is to be held, probably, off the New England coast within the next few weeks, when it will be possible to determine the greatest steaming radius of each vessel.

The "Chester" is the Bath cruiser equipped with Parsons turbines, the "Birmingham" the Fore River cruiser equipped with triple-expansion engines and the "Salem" the Fore River cruiser equipped with Curtis turbines. On the builder's trial trip the "Chester" developed an average speed of 26.53 knots for four hours and showed a burst of speed of 26.6 knots, maintaining an average speed for 24 hours of 22.5 knots. Her coal consumption on this 24-hour trial was 2.82 knots per ton of coal. Her best mile on standardization was at the rate of 26.22 knots and the average of her five fastest runs was 25.1 knots.

The "Birmingham" was given a 24-hour builder's test at a cruising speed of 12.228 knots and it was found that she consumed one ton of coal while making 5.96 knots at this speed. She was steamed at 22.665 knots for 24 hours and averaged 2.475 knots per ton of coal with screws making 170.22 revolutions per minute.

The "Salem," the first Government vessel to be propelled by an American designed and built turbine, covered a measured mile at the rate of 26.8857 knots. She began her standardizing test at a 12-knot speed, gradually increasing until the seventh lap, when she made the first of her five top-speed runs. On the ninth run she made a mile in 2 minutes 13.9 seconds, which was at the rate of 26.8857 knots per hour. The next fastest run was at the rate of 26.5 knots, and the average of the five fastest runs was 25.954 knots.

The "Salem" displacement during the trial was 3788 tons, her draft was 16 feet 9¾ inches and the estimated horse-power development 20,000. She was also given a four-hour test and made an average of 25.956 knots, and an average of 26.01 knots for the second and third hours. The average speed of her screws for the four hours was 378.39 revolutions per minute. The average screw speed to develop 24 knots was 348 revolutions per minute.

The results of the foregoing trials are shown in the accompanying table.

U. S. SCOUT CRUISER TRIALS.

Item.	"Birmingham." (Reciprocating.)	"Salem." (Parsons.)	"Chester." (Curtis.)
Standardization:			
Best uncorrected run on course, knots	25.193	26.886	26.22
Mean of best pair of runs, knots	24.477	26.11	25.138
Mean of five high runs, knots	24.236	25.957	25.074
R.P.M. for 24 knots	187.23	335.2	507.25
R.P.M. for 2275 knots	170.38	312.0	466.4
R.P.M. for 12	89.7	165.0	245.5
Full speed—four-hour trial:			
Mean speed for 4 hours	24.325	25.947	26.52
Best 2 hours		26.01	
Mean R.P.M. for 4 hours	191.66	378.39	614.0
Coal per hour, lb	29,904.0	38,502.0	38,332.0
Indicated horse-power	15,540.0		
Brake horse-power		19,200.0	unknown
Coal per I.H.P. per hour	1.92	1.81	unknown
Coal per B.H.P. per hour		2.01	unknown
Knots per ton of coal	1.822	1.51	1.548
Twenty-four hours at 22.5 knots:			
Mean speed for 24 hours	22.665	22.536	22.78
Mean R.P.M.	172.1	312.535	473.5
Coal per hour, lb	20,510.0	18,485.0	18,063.0
Indicated horse-power	10,760.0		
Brake horse-power		9,340.0	unknown
Coal per I.H.P. per hour	1.91	1.78*	
Coal per B.H.P. per hour		1.97	unknown
Knots per ton of coal	2.47	2.73	2.82
Twenty-four hours at 12 knots:			
Mean speed for 24 hours	12.228	11.93	12.2
Mean R.P.M.	91.4	164.11	250.0
Coal per hour, lb	4,629.0	4,051.0	4,091.0
Indicated horse-power	1,600.0		
Brake horse-power		1,360.0	unknown
Coal per I.H.P. per hour	2.89	2.68*	
Coal per B.H.P. per hour		2.98	unknown
Knots per ton of coal	5.965	6.6	6.68

*Equivalent I.H.P. based on assumption of 10 per cent. engine friction.

Harlan & Wolff are building a pair of steamers for the Dominion line which are fitted with reciprocating engines to be worked in connection with steam turbines. The engines, we understand, will be triple-expansion, and the turbines will take the steam at slightly above the atmospheric pressure, making the engine in effect a quadruple, with a large ratio for the final cylinder.

The High Pressure Hydraulic Elevator

Adjustment and Care of Automatic Stop Valves and Mechanism; How to Pack the Different Parts, and the Kinds of Packing Used

BY WILLIAM BAXTER, JR.

The automatic stop valves of high-pressure elevators and their actuating mechanism require the same attention as those of low-pressure machines, and keeping them in perfect adjustment and running order at all times is just as necessary, because the safety of the elevator depends on them in the same degree. Several designs of automatic stop valve were shown in the articles describing high-pressure machines and there are several others that were not shown. All those previously described, with the exception of Fig. 221, which was published in the April 21 number, and is reproduced herewith, are substantially the same as those shown in connection with low-pressure machines, and those that were not illustrated are of practically the same type. Stop valves of this kind, in almost every case, are operated by means of an actuating rope upon which stop balls are secured at the proper points to bring the car to a state of rest level with the top and bottom floors; and what has been said in previous articles relative to the care and adjustment of such mechanism applies equally to the stop valves and actuating devices used in high-pressure systems.

The valve in Fig. 221, however, requires some additional consideration owing to the fact that it can be got so far out of adjustment as to cause considerable damage. Fig. 221 shows that the connecting-rods that connect the crank lever C with the valve stem and with the rod L that runs up to the top stop lever are provided with right- and left-hand screw couplings by means of which their length can be varied. It also shows that the valve E is held normally in the central position by the spring S, which forces the upper head F against the upper end of the spring casing, and the lower head F' against the lower end G'. This being the case, any change made in the length of the connections, whether with the valve or with the rod L, will have the effect of varying the position of the lever C and likewise that of the corresponding lever at the upper end of the rod L. All this will be perfectly clear by the aid of the diagram, Fig. 232, where E' represents the position in which the valve E is normally held, while line A represents the normal position of lever A and a, the position into which it is pushed by the lower roller R mounted on the traveling sheave frame T, b represents the normal position of the upper A lever and B and B' are the centers around which these levers move. The turnbuckles by means of which the connections with the upper end of the valve and the lower end of the rod L are varied in length are represented by D and F. With D adjusted so that the lever C stands in the horizontal position when the valve is in the central position E', if L is of the same length as the distance between B and B', the upper lever C' will also rest in the horizontal position, the lower lever A will be in the position shown, and the upper lever A in the position of the line b. If now the traveling sheave comes down, the stop roller R will strike A and depress it to the position a to shift the stop valve to the stop position. If the traveling sheave runs upward, the upper stop roller R will strike the lever A in the position b and carry it to the position b' to move the valve to the upper stop position. Now suppose the turnbuckle D is lengthened; then since the valve E will be held in the position E' by the tension of the spring S (see Fig. 221), the lever C will be moved upward, and if the rod L is not shortened, the upper lever C' will be forced up above the horizontal position, and so will the lever A'. If, with this change in the adjustment, the traveling sheave runs down the stop roller R will strike the lever A when it reaches the position f, because the lever A will now rest in the position of broken line a' and when the roller has reached the position f' the valve will be moved to the stop position, thus stopping the movement of the traveling sheave within the distance x; while before the turnbuckle D was lengthened the roller R traveled from R' to R'' to move the valve to the stop position, equal to the distance y.

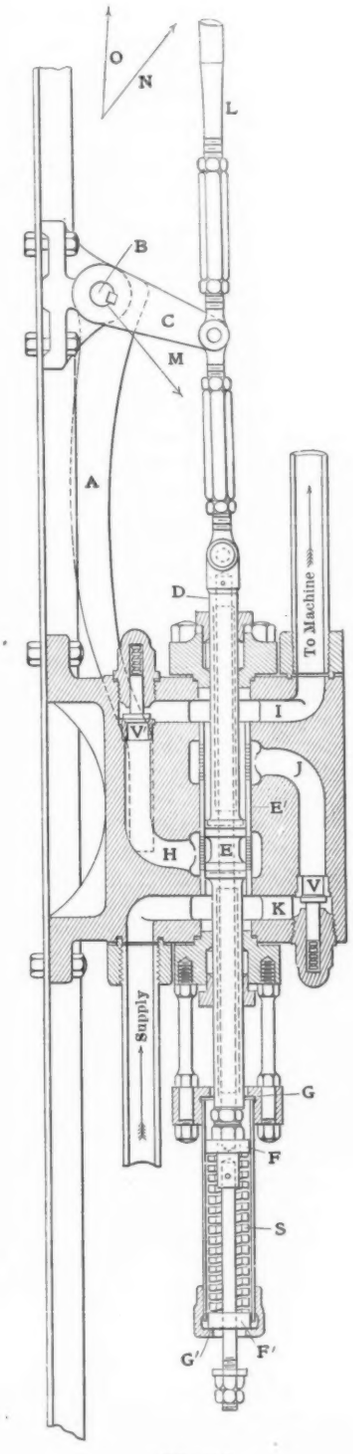


FIG. 221
(Reproduced)

Looking at the upper end of the diagram it is clear that, as the lever A' has been shifted to the position in which it is drawn, the upper stop roller R on the traveling sheave will have to reach the position b before it begins to move the lever A', and as the lever will have to move to the position A, to close the valve, the latter will not be closed, and as a result the traveling sheave will continue moving until stopped by some other means. From all this it can be seen that unless the turnbuckle D is lengthened very little, the upper lever A will be rotated so far around that the stop roller on the traveling sheave will not be able to move it far enough to close the stop valve E. If, however, the connection F

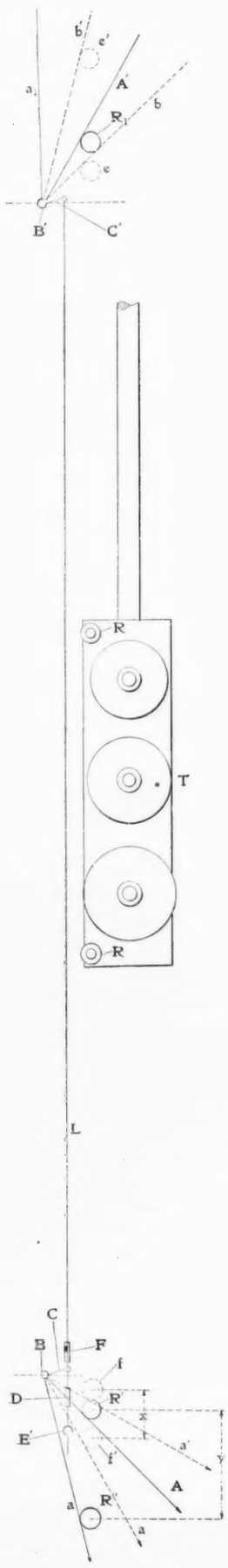


FIG. 232

is reduced in length so as to cause the lever C' to rest in the horizontal position normally, then the traveling sheave stop roller R will be able to close the valve fully because the lever A' will have to be moved from the position b to the position b'.

By adjusting the lengths of the connections D and F, the distance the car will travel after the stop valve begins to move can be varied. Suppose D is made longer, then the lever C will be pushed upward, as shown in Fig. 233, and if F is shortened twice as much as D is lengthened, the upper lever C' will rest below the horizontal line, so that the upper and the lower levers A will stand at the same angles above and below the horizontal; consequently the distance the traveling sheave will move at each end of its travel before the car stops will be the same, being equal to the distance between the circles R' and R'', which is less than the distance y in Fig. 232, because D has been made longer. Suppose now that D is made shorter; then the lever C will be drawn down as shown in Fig. 234, and to cause the upper lever A to rest at the same angle above the horizontal line that the lower lever A does below this line, F will have to be lengthened out just twice as much as D was shortened. With this change in the adjustment, the traveling sheave will have to move the distance indicated by circles R and R' to shift the valve E to the stop position, and this distance is more than y in Fig. 232.

It will be noticed, however, that in Fig. 233 the valve will be closed sooner than in Fig. 234, this being clearly indicated by the position of the circle R'' at the lower end of both diagrams. This simply means that if the change indicated in Fig. 233 is made the car will stop short of the floor at the top and bottom, and if the change indicated in Fig. 234 is made the car will run beyond the floor at both landings. From this it follows that if the car runs too far at one or both landings, it can be made to stop even with the floor by making D longer, as in Fig. 233, being careful to shorten F the proper amount; and if it stops short of the proper point the defect can be remedied by making D shorter and F longer. If it is desired to effect the stop in a shorter distance and still have the car stop even with the floor, the only way to do it will be by shifting the whole valve so that the distance between centers and B and B' may be increased in the proper amount. If it is desired to make the stop slower, as in Fig. 234, the valve will have to be shifted so as to reduce the distance between B and B'.

Dangerous to Change Adjustments

It should be remembered, however, that unless one is thoroughly familiar with the operation of every part of an elevator system it is very dangerous to make changes in the adjustment, unless it is known that some part has changed from its original position and requires being restored to this position. To illustrate the importance of this point, take the matter of changing the distance in which the car is stopped, which can be accomplished by adjusting D and F in the manner just described. By this method the stopping distance can be changed, but if it is made too short, the passengers may get a bad shaking up, while if it is made too long there will be an unneces-

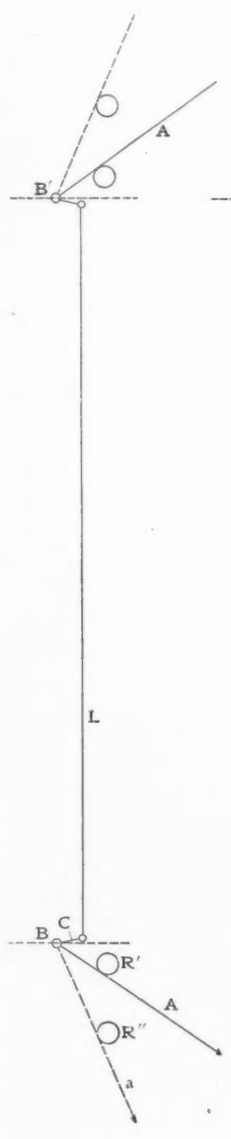


FIG. 233

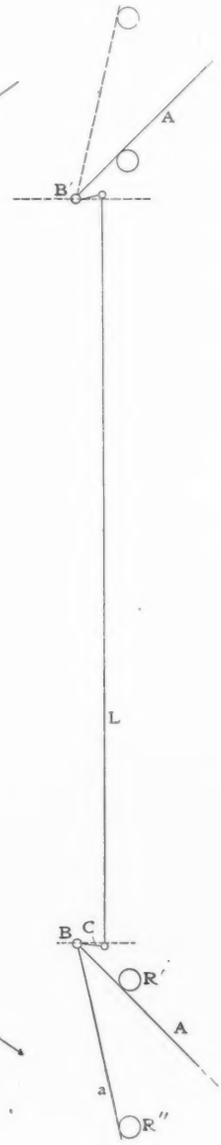


FIG. 234

sary loss of time. The engineers of the elevator builders know as much as anyone about the proper adjustment of the stop-motion apparatus, if not a great deal more; and, generally, nothing can be gained but probably a good deal lost by trying to improve on their work. The knowledge of how to make these adjustments should only be utilized in restoring the parts to their original position if for any reason they become displaced.

While the stop-motion valve of Fig. 221

was shown only in connection with a vertical machine, it can be used just as well with the horizontal cylinder, and in like manner the stop valve shown with the latter type of machine in an earlier article

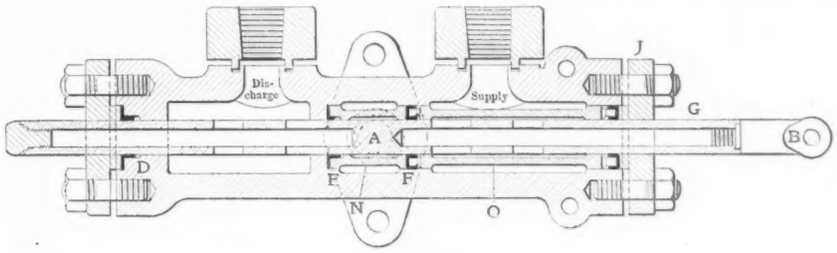


FIG. 235

can be used with the vertical cylinder. The adjustment of the latter type of valve is effected in the same way as that of the Whittier horizontal machine; that is, by changing the position of the stops that are moved by the operating arm attached to the traveling sheave crosshead. These stops, in Fig. 204, are marked *E E* and *E E* and are mounted on a rod *E″*, but this rod is connected with the rope *D* that rotates the stop valve by means of the arm *E′*, so that changing the position of *E E* amounts to the same thing as changing the position of stop balls placed directly upon the rope *D*. If it is desired to have the car stop higher up at the top floor, the stop *E E* at the end of the machine is moved forward, the distance moved being equal to the additional travel required, divided by the gear of the machine. To cause the car to run farther down at the bottom floor, the stop *E E* nearest to the cylinder is shifted back toward the cylinder through a distance equal to the required increase in travel divided by the gear of the machine. To shift the stopping points of the car in the opposite directions the stops are moved in the opposite directions, of course.

There is one difference between stop valves of the type shown in Fig. 204 and that of Fig. 221, and that is that with the former it is only possible to vary the point at which the elevator car will stop, while with the latter not only can the stopping point be varied, but also the distance in which the car will stop. With valves like that of Fig. 204 the stopping distance can be changed only by changing the form of the edges of the valve, or of the ports covered by the valve, so as to vary the angular distance through which the valve must be moved to stop the flow of water. While this might be regarded as a point in favor of the valve of Fig. 221, it is very doubtful if it is, because if the stopping distance is once made right it will always be right; hence, there is no need of providing means for adjusting it. The valve in Fig. 221 happens to be of such construction as to permit varying the distance in which the car can be stopped, but such adjustment is unnecessary, and with a fussy attendant who always wants to be doing something that he should not do, it may be positively objectionable.

The main valve used with high-pressure machines is the same for either the vertical or horizontal type. In almost every case the pilot-valve design is used, but occasionally a simple valve for hand-rope or hand-wheel operation is installed. So far as the main valve is concerned, there is no difference between the two types, as can be clearly seen by reference to Figs. 235 and 236, the first being the simple hand-rope-operated valve, and the second the

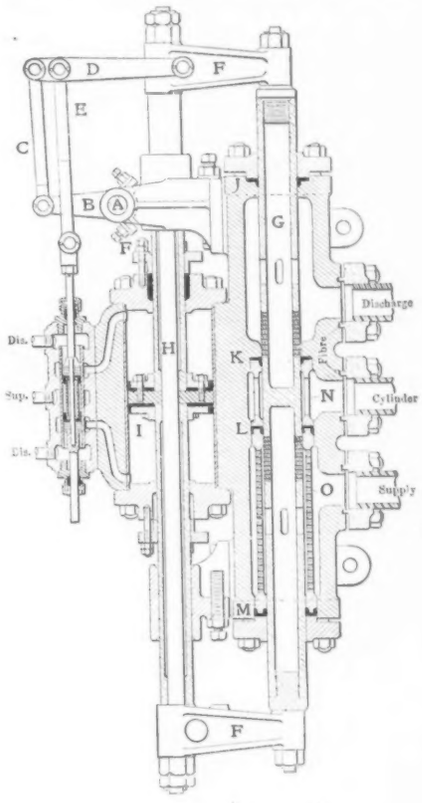


FIG. 236

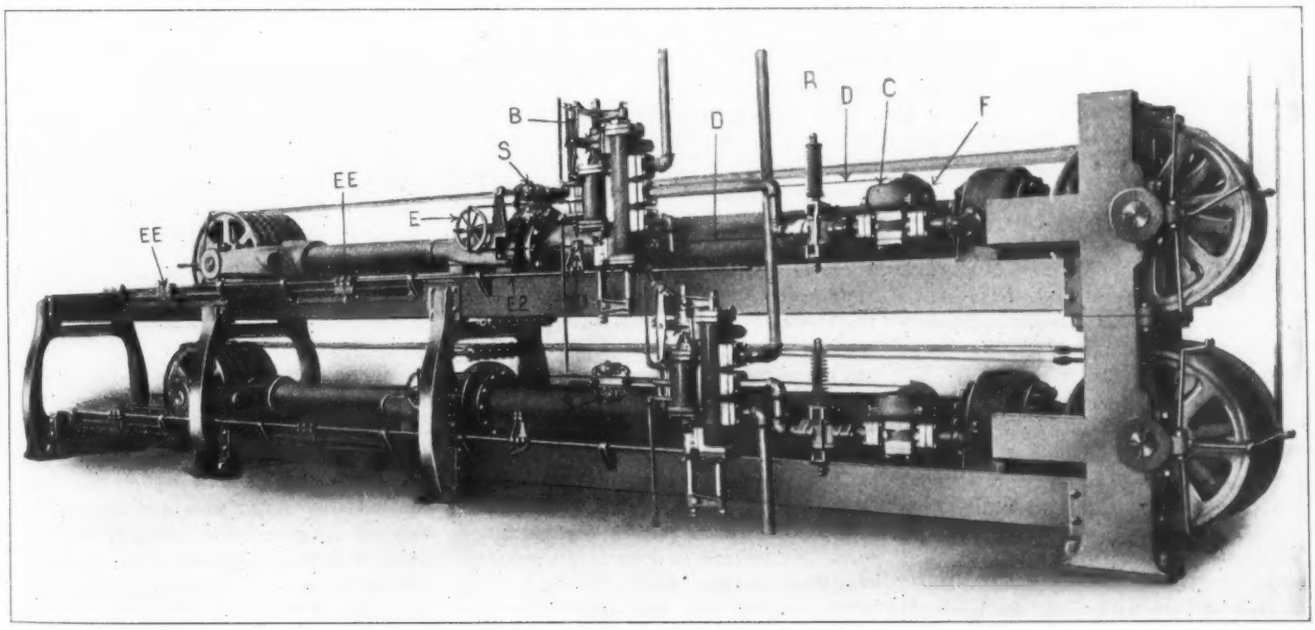


FIG. 204
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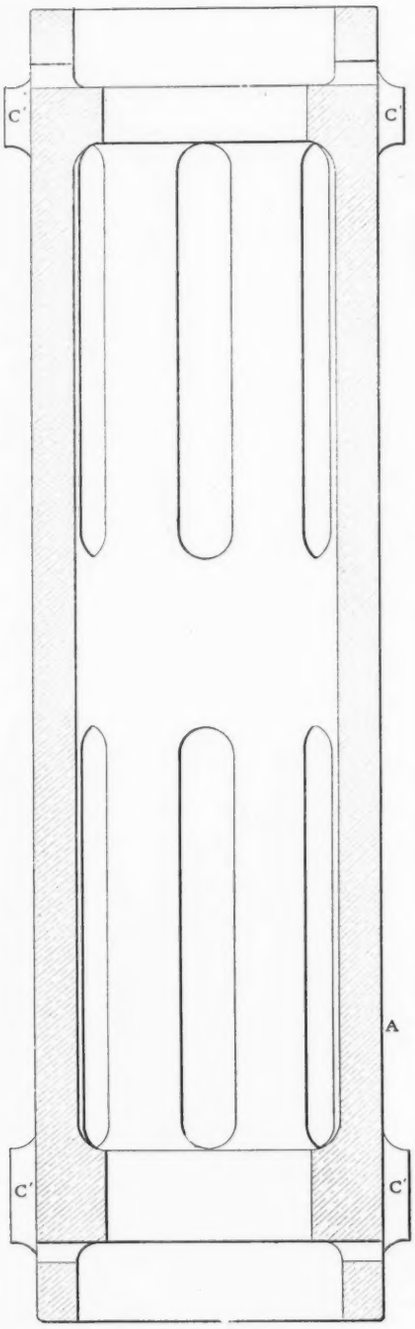


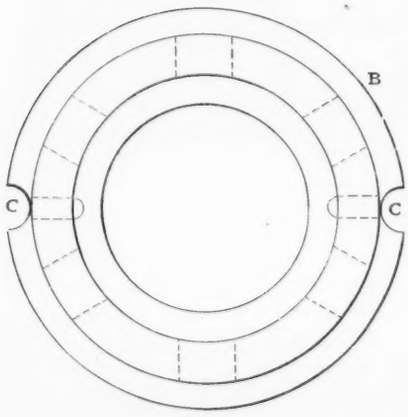


FIG. 237

more elaborate pilot-valve arrangement. In both these illustrations the main valve is marked *G*, and both are the same, with the exception of the ends, Fig. 235 showing means at the end *B* for connecting with the moving mechanism, while Fig. 236 shows ends adapted to receive arms, *F* and *F*. Even this difference does not always exist, because generally the operating rack and pinion are placed by the side of the valve, so that the rack actually occupies the position of the piston-rod *H* in Fig. 236.

The Packings

All the packings of the high-pressure valve *G* are leather cups, and they are removed or inserted by removing the head *J*, Fig. 235, and the cylinder linings *O* and *N*. The construction of these linings, which are made of brass, is shown in Fig. 237, which is the part *O*, and Fig. 238, which is the part *N*. Both drawings show a section *A* parallel with the axis of the cylinder and an end view *B*. In Fig. 237 it will be noticed that the end view *B* shows semi-circular grooves at *C C*. These are made in the flanges *C'* and *C'*, seen in the section *A*, and are for the purpose of permitting the water to flow in freely and force out the cup packings, as is easily understood from looking at Figs. 235 and 236. Fig. 238 does not show these grooves, but at one end shows a hole *C* through which water passes to force the packing *E* into position, as shown in Fig. 235. The packings *M* and *L* are made double cups as they have to make tight joints against the valve as well as against the outer casing. The other two packings have to make a joint only against the valve.

To remove these cup packings it is necessary to draw out the valve, and in the case of Fig. 236 this can be easily done by taking off the lower arm *F* and freeing the valve from the upper arm *F*. The lower head is then removed and the parts *O* and *N* are drawn down. The stuffing-boxes of the pilot valve and of the rod *H* can be packed without removing any parts except the glands. To take out the piston *I* it is easier to remove the lower cylinder-head and piston-rod guide than the upper ones, as in so doing it is not necessary to disturb the levers *B D* of the rods *C E*. The pilot valve can be easily removed by taking off the top cap, the lever *B* and the rod *E*. Whenever any work of this kind is done it is necessary, of course, first to close the hand valve in the supply pipe and then drain the water out of the cylinder and pipes. After the work is completed the supply-pipe valve is opened and the air is withdrawn from the cylinder and piping. To get all the air out it may be necessary to make a few trips with the car.

The lifting plunger is packed by means of a stuffing-box at the end of the cylinder, the construction of which for both the vertical and the horizontal machines was shown in the illustrations presented in previous articles on high-pressure machines. Any kind of packing can be used in these boxes, but plain hemp with tallow works as well as can be desired, provided it is properly put in. As the pressure used in the cylinder is high, the packing must be put in the box evenly in order that there may be no soft spots, for if there are, the water will find them and force its way through, although the other parts may be pressed up hard. It is necessary to force the stuffing-box gland up tight to make a joint against the pressure used (750 pounds), but it is always desirable to compress the packing as little

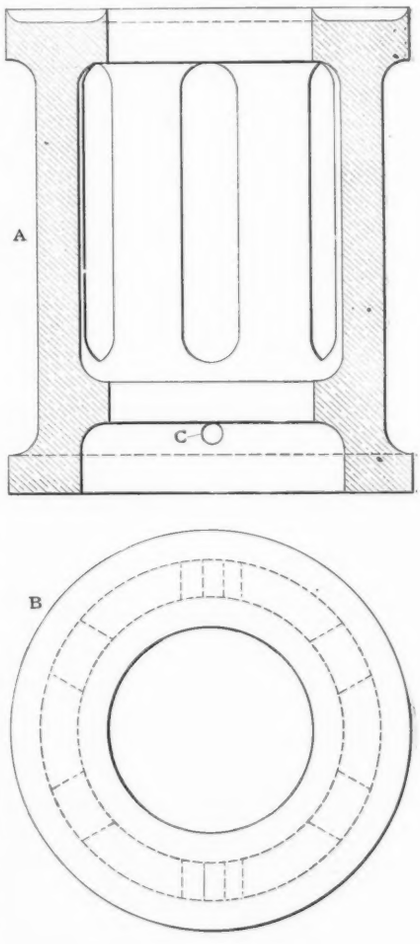


FIG. 238

as possible in order to reduce the friction, and the extent to which the packing must be compressed to make it tight depends in a large measure upon the evenness with which it is placed in the stuffing-box. If it is crowded in tight on one side and is mushy on the other, no amount of tightening will keep it from leaking.

The cylinder may be packed with the car at the top of the building or at the lower floor. If it is at the upper floor, it must be secured to the overhead beams before the water is withdrawn. If it is at the bottom floor, and the traveling sheave comes so near to the stuffing-box as to interfere with free working, the car

should be stopped a few feet above the floor and a temporary support put under it. The distance above the floor at which the car should be held can be determined by multiplying the gear of the machine by the additional room required to get at the stuffing-box easily.

An accumulator is packed at the upper end, by means of a stuffing-box, the same as the lifting cylinder. To do the packing the water is drawn out of the cylinder and the hand valve in the inlet pipe is closed. When the cylinder is empty the upper end projects above the accumulator weights, as shown in Fig. 239, and the stuffing-box can be easily reached. Just as much care is required in packing the accumulator as in packing the lifting cylinder, because they are subjected to the same pressure. The stuffing-boxes of high-pressure machines are made deeper

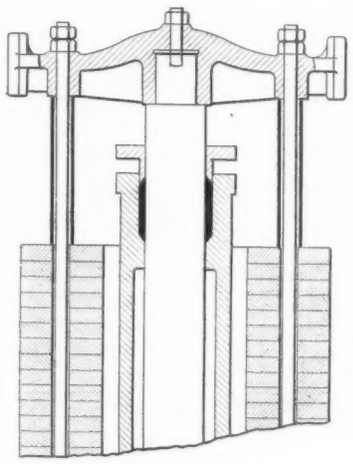


FIG. 239

than those used with low-pressure apparatus, but even with this extra depth they cannot be made tight and maintained tight unless the packing is done with care.

Longest Wire Rope Carrier

Russian journals report the approach to completion of what is claimed to be the longest wire-rope carrier in the world, and of all places in the world, in Turkestan. The ancient city of Samarcand obtains its fuel from coal mines 80 miles distant, the road to which is so difficult that wheeled vehicles cannot traverse it, and the coal is brought on camels, which carry 360 to 430 pounds each, taking five days for the journey. This costs about 35 cents per 100 pounds (and very cheap at that). The ordinary fuel of that part of the world consists of cow dung and the grass of the steppes compressed into cakes. But for a city like Samarcand the supply is short. The cable carrier will be 54 miles long, beginning at a station of the Asiatic midland.—*Railroad Age Gazette.*

A Common Gas Producer "Trouble"

BY F. C. TRYON

A gas-producer plant installed to supply both power and heat lacked, for some reason, the ability to supply the amount of gas required for both at the same time. The producer was designed for 150 horsepower, and was 4 feet 6 inches inside diameter. It was supplying gas to a 100-horsepower engine supposed to be developing about 90 horsepower only. The additional 50 horsepower capacity of producer plant was also supposed to be ample to furnish the heat required for a soldering plant originally designed to operate on city gas.

The entire power and heating outfit was figured on the basis of another similar plant located in another place in which steam power was used for driving the machinery and city gas for the heating. It was the intention to install the same number of machines in the new plant and the amount of power required to drive these machines was well known. Sixty horsepower was said to be the load the engine would have to carry at first, and this would be increased, as new machines were installed, to 90 horsepower — the ultimate maximum load that the engine would have to carry. In designing the new factory building considerable more space was allowed to each machine than the old factory had, and a few extra feet were added in each direction, so the new plant really was about 50 per cent. larger in area than the old one.

There was considerable delay in getting the gas engine of the new factory delivered, so temporary gas and gasolene engines were installed, and the delay caused the orders to accumulate. While the new engine was being installed it was thought that putting in at once the additional machines would be the quickest way to catch up with the demand and stop the complaints about the non-delivery of goods ordered.

While the engine was being installed the producer was supplying gas to the heating plant in a fairly satisfactory manner, but when the engine was put in operation trouble developed. The exhauster supplying gas to the heating outfit would rob the engine, which was taking its gas by piston suction from the same dry scrubber, or the engine would get most of the gas and the heating outfit would be "starved." Then the producer commenced "doing things." It would get so hot it was almost impossible to work around it; the gas would run so poor that the engine would slow down and the gas would not burn at the soldering burners. The producer was of the type in which a certain amount of water is thrown on a hot plate surrounding the fire bed, just above the grate, at every suction stroke of the engine, the amount of water injected being determined by the degree of vacuum created in the gas main by the engine piston. The water injected on this plate was supposed to be evaporated, the steam being drawn into the fuel bed with the air supply. Although this supply of steam was intended to prevent the formation of clinkers, clinker trouble developed quickly, as well as excess of CO_2.

It was charged by the engine builders that the trouble was poor fuel. A sample was sent for analysis and found to contain 29 per cent. of ash; another fuel was substituted, but the results did not entirely prove fuel troubles. After considerable bickering it was finally discovered that the factory superintendent had installed four more machines than were originally intended on the basis of a total load of 90 horsepower, and the engine was carrying, as nearly as could be estimated, 120 horsepower. The four extra machines had also increased the demands on the heating plant about 15 per cent. In short, the chief cause of all the trouble was plain, common overloading.

A California Power Plant

The Great Western Power Company has commenced work on its extensive dam at the intake of the Big Bend tunnel in Butte county, Cal. Electric cars run through the tunnel from the power plant at the lower end to the dam at the upper, conveying material. The tunnel is 3 miles long and 18 feet high in the clear, lined with cement. This same company has commenced work also on its transformation substation in East Oakland. This is at Sessions basin on the edge of the deep water in Oakland harbor. On this same property will be erected a steam-power plant to develop 25,000 horsepower by the use of fuel oil, as an auxiliary. The transmission lines are now in course of construction, and between 30 and 40 miles of them have been finished. Stretches have been completed above Oroville, in Sacramento county. The transmission cables are carried on steel towers 30 feet in hight, and it is expected that the first installation will have been completed by October. At this time the delivery of 65,000 horsepower of electrical energy will begin. The transmission line, when completed, will pass through Butte, Sutter, Sacramento, Yolo, Contra Costa and Alameda counties, crossing the San Joaquin river at Antioch. It is generally understood that much of the power generated at the Big Bend electric plant will eventually be used on the lines of the Western Pacific Railroad.—*Engineering and Mining Journal.*

Eighty-eight per cent. efficiency can be realized in electric motors of 20 horsepower capacity and upward.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

How to Make a Coal Register and an Automatic Trap and Put in a Crank Pin

An automatic coal register which most anyone can make is shown in Fig. 1. The counter was made from an old water meter by substituting a small lever and ratchet in place of the endless screw. Two magnets were wound and the armature lever connected to the lever of the counter. Our coal truck holds 1000 pounds and as the truck is drawn into the boiler room, it passes through a frog grinding the wheels, thus keeping the truck in line and at a proper distance from the "trip-stand." A projecting plate on the body of the truck engages the trip, which in turn closes the circuit. The trip has an elbow joint so that when the truck returns empty to the coal bin it breaks the joint at the elbow and does not register.

The batteries may be placed in an out of the way place, and the register may be placed in the engine room or office. This has been found most convenient as each twenty-four hours we know just how much coal has been consumed.

A trap for keeping water out of pits or pump room, or any place where it would be difficult or impossible to drain, is shown in Fig. 2, which explains itself. The float staff is connected to an arm which is connected to a 3-inch whistle valve. As the water raises in the sewer the float raises and opens the whistle valve, which is piped to a jet, which in turn draws the water up and discharges it. This is automatic and will be found to work perfectly. It is best to have a globe valve close to the whistle valve and only open it one-quarter turn, which will make the float work easier and consume less steam.

In Fig. 3 is shown how we recently

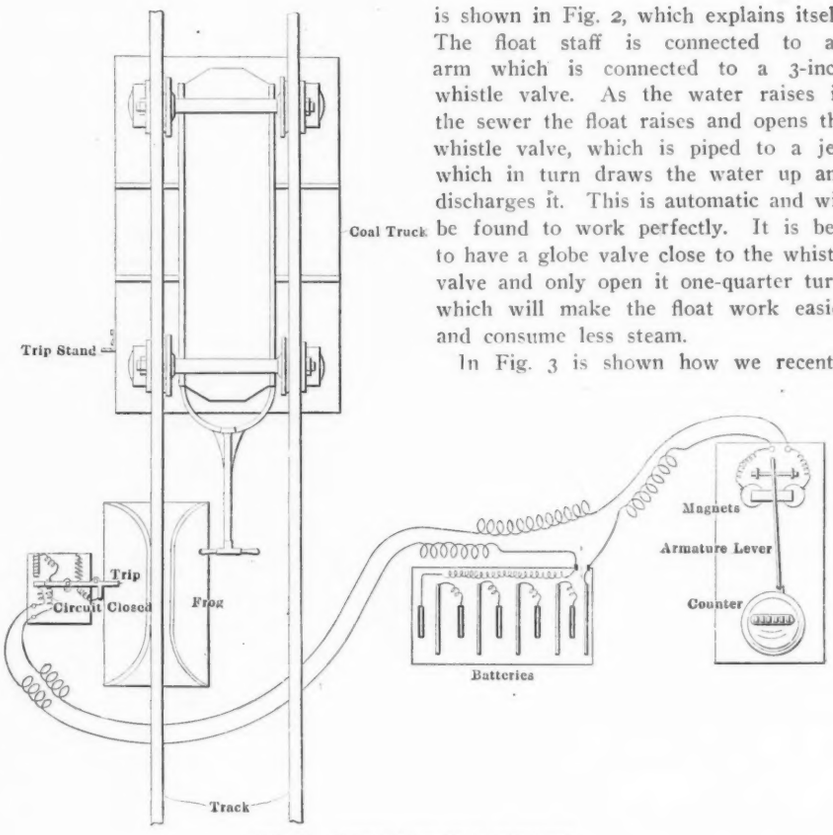


FIG. 1. AUTOMATIC COAL REGISTER

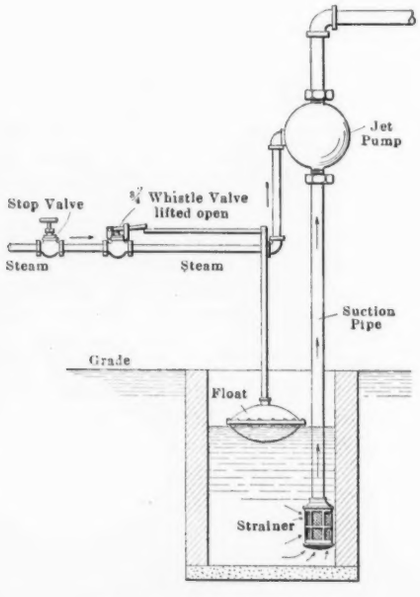


FIG. 2. AUTOMATIC TRAP

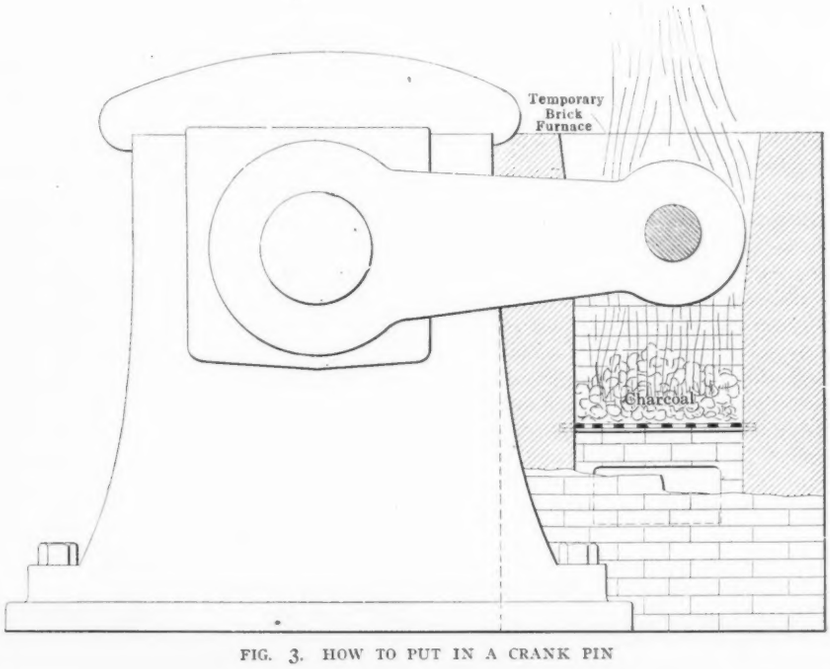


FIG. 3. HOW TO PUT IN A CRANK PIN

put in a new crank pin, the old one having begun to work loose. The hole in the disk was bored out and the new pin turned 13/1000 of an inch larger than the hole. The disk was then heated to a cherry red by building a brick flue around it and using charcoal, which only should be used, as coal or coke will overheat the outside before the inside is heated and so ruin the disk. When all was ready the fire was removed and the pin placed in the hole by hand. This operation requires quick work, for if ever the pin stops before it is in place the job is "off" and the pin will have to be drilled out. This is the easiest and the most particular way of putting in a pin, and if done right by far the most successful. I have never known of one put in this way that became loose.

W. E. TURNER.

Wilmington, O.

Natural Gas Burner

The following is for the benefit of F. Remington, who wishes to change from burning coal to gas as a fuel:

I had charge of the Ponca City Light Plant when they changed from coal to gas two years ago. The cost for one month on nut coal costing $3.25 per ton was $153 per month. For gas with the same load the cost was $159 per month, at the rate of 8 cents per thousand feet.

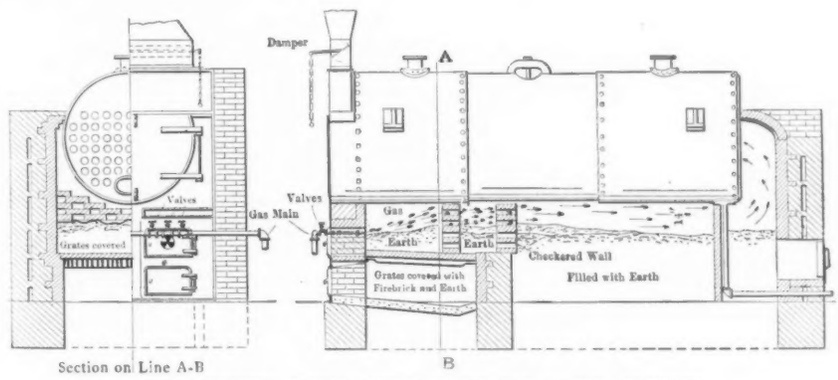
The way I set the burner was to tear the bridge-wall down and fill up the combustion chamber with dirt until only 14 inches of space was left between the boiler and the dirt at the back end of the boiler. I also put bricks on the grate-bars and placed enough dirt on top of the bricks to allow about 9 or 10 inches from the boiler to the top of the boiler shell. The hight of the stack is immaterial, as a damper will be necessary, and kept nearly closed at that.

I am now in charge of a water-works plant having two 48-inch by 14-foot boilers, and the cost of coal here was $150 per month, but we have changed to gas on a flat rate of $60 per month, a saving of $90 in the fuel bill.

We have but two burners to each fire door, while the electric-light plant has three.

B. K. STANLEY.

Ponca City, Okla.



GAS-BURNER INSTALLATION SUBMITTED BY MR. STANLEY

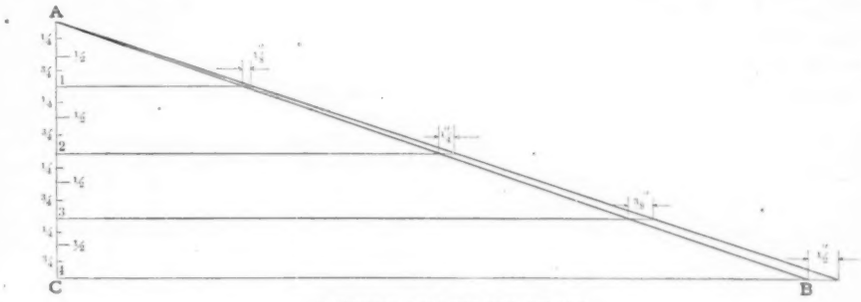
casing of the burner; two checkered walls being placed in the furnace crosswise of the boiler for the gas to strike against. The first wall should be 36 inches from the end of the burner and the second wall about 18 inches from the first, and extending up to within two inches of the

Packing Measuring Chart

A handy device for measuring packings can easily be made as follows: Take a large board and lay off a straight line, marking spaces to correspond to the diameters of the rods requiring the packing. At one point, such as 4-inch, lay off at right angles to this line, a line equal to four times 3.1416. This is the exact circumference of a 4-inch rod. From the end of this line draw a line to the other end of the first line, thus making a triangle, and draw parallel lines as shown in the sketch at the 3-, 2- and 1-inch marks, etc. Each one of these lines will represent the circumference of the corresponding rod diameter.

To allow for end expansion, a ring should never meet around a rod. The amount allowed varies with the judgment of the engineer. Suppose he wishes to allow ½ inch on a 4-inch rod. Then lay off from the end of the 4-inch line, as shown in the drawing, ½ inch, and draw a line from there to the apex of the triangle. This line *AB* and the line *AC* mark the limits of the packing as it is to be cut off.

There is one other allowance to be made. The real diameter of a packing ring is the rod diameter, plus the thickness of the ring. If, then, you wish to cut off a piece of packing ½-inch thick for a 2-inch rod, place one end of the packing on the line *AC* at the 2½-inch mark, and cut the packing where it cuts the line *AB*. A series of light lines can be dotted across the board at the angle at which it is desired to scarf the rings. This is simply a convenient guide for the eye in cutting the packing. The distances marked in the line *AC* need not be actual inches, but must be proportional. A board marked in this way is convenient for cutting any size packing at any time.



A PACKING MEASURING CHART

W. E. SANDERS.

Cleveland, Ohio.

What Caused the Intermittent Gas Explosions?

After putting a heavier bank of ashes than common on the fire in the grate one night last winter, there suddenly occurred a distinct, but soft, report and flash. I kept a close watch of these explosions as long as it lasted, which was perhaps ten minutes, or more. For the first five minutes the time of ignition did not vary; about three explosions to the minute. After the first five minutes the time of ignition became gradually farther removed and the force of the explosion weaker, until the last explosion was not distinguishable except for a slight glow.

Why did the gases explode in intermittent charges, and did the same degree of heat set them all off alike? The heat being present all the while, unlike the predestined spark in an engine, and the gases in the last stages being perceptibly weaker, why did not the gases in the beginning ignite at a lower quality of richness and burn longer, instead of with a quicker flash than when they became weaker?

LLOYD V. BEETS.

Nashville, Tenn.

Hollow Shaft Constants

Hollow shafts, columns, beams, etc., of circular section, are used in many of the engines and machines now built because of the great saving in weight which may be effected by removing the metal which is not so advantageously situated. It is, therefore, often necessary to find the diameter of a hollow shaft which has the same strength as a given solid section.

The formula which is always given in text and reference books is the expression

$$d^3 = \frac{D_1^4 - D_2^4}{D_1},$$

where

d = The diameter of the solid shaft,
D_1 = The outside diameter of the equivalent hollow shaft,
D_2 = The inside diameter of the equivalent hollow shaft.

As this expression involves finding fourth powers and extracting cube roots, it is inconvenient to apply. Since the problem is generally to find the diameter of a hollow shaft, having assumed a value of the ratio $\frac{D_2}{D_1}$, generally between 0.5 and 0.7, it is possible to plot a curve which will give the value of a constant K for each value of $\frac{D_2}{D_1}$, by which d must be multiplied to find the equivalent D_1. Such a curve is shown by the solid line marked K, on the accompanying diagram. An additional curve marked (%) has been plotted, showing the saving in weight over a solid shaft, which makes it possible to easily find the diameter of a hollow shaft which will be a certain per cent. lighter than the equivalent solid shaft.

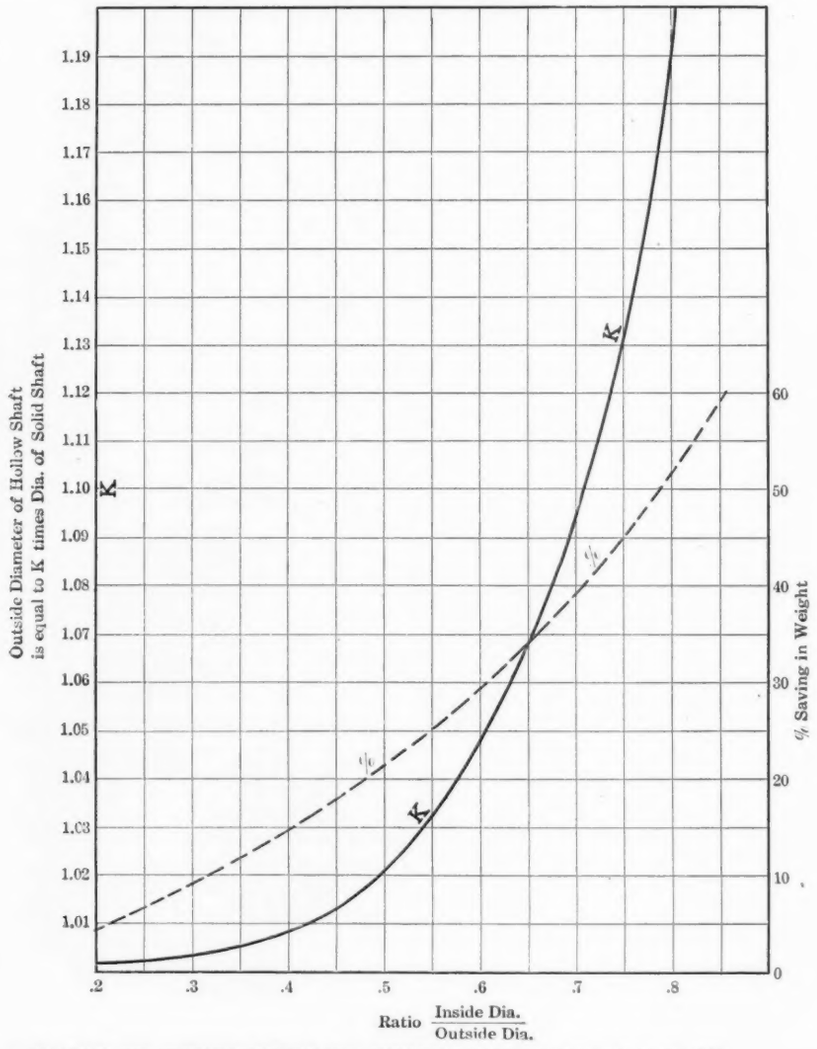


DIAGRAM FOR FINDING EQUIVALENT HOLLOW SHAFTS, COLUMNS OR BEAMS

To illustrate the use of these curves, let it be required to find the dimensions of a hollow shaft equal in strength to a solid shaft 10 inches in diameter, but weighing 50 per cent. less.

Referring to the diagram, follow the line marked 50 per cent. to the left till it intersects the dotted curve and then follow the vertical line passing through their intersection until it meets the curve marked K. Opposite the intersection of the vertical and the curve K, will be found the value, $K = 1.174$. Hence, the outside diameter of the hollow shaft must be $10 \times 1.174 = 11.74$ inches, and the inside diameter will evidently be $0.79 \times 11.74 = 9.275$ inches.

To work out this problem by the formula generally given would take at least half an hour.

H. F. SCHMIDT.

Chicago, Ill.

Cross Currents

Regarding O. A. Webster's trouble with cross current, as set forth in the June 30 number, page 1042, of POWER AND THE ENGINEER I believe it is not a wattless, but an energy current, and that the trouble is caused by irregularity in the speed of the water wheels or by a splice in the driving belt. The water wheels may contain certain buckets having larger capacities than the others and these receiving the force of the water at the same time would cause the wheel to speed up during a portion of each revolution. The alternator being a high frequency machine, the least change in its velocity would cause a phase displacement between it and the motor, the energy current being that which momentarily flows in the motor to keep it at the proper phase with the generator.

The reason this is not noticed so much when the motor is unloaded is because it can adapt itself more easily to the generator, but when loaded this change is not so easily brought about.

The reason for the coil burning out is more on account of a defect in the motor than that of the trouble mentioned.

The 30-kilowatt machine is satisfactory for the service, if the load is not too heavy, but it is more advisable to change the system from 133 cycles to 60 cycles if possible, and to use an indction motor.

In answer to Mr. Thompson's question in the June 23 number, page 997, regarding his circulating pump, I would say that if the pump discharged into a stand-pipe as high as the pump was capable of sending the water, the motor driving the pump would be doing the greatest amount of work, because it would have to drive the valves in the pump to hold up the column of water and also overcome the friction of churning. This is the condition under which the motor requires 65 amperes. If a valve at the discharge outlet of the pump is closed the motor would not have to support the column of water, but merely overcome the churning, under which condition the motor requires but 30 amperes. These two conditions represent the condenser when the tubes are clear and when plugged.

I would advise Mr. Thompson to get rid of the elbows on the suction side of the pump if possible.

JAMES E. KILROY.

Lincoln Place, Penn.

Steam Loop Gives Trouble

I would like to ask the engineers who read POWER AND THE ENGINEER if any of them operate a steam loop, and if it works successfully?

I herewith submit a diagram of one I have, but it does not work properly.

The boiler is of 80-horsepower capacity, carrying 90 pounds steam pressure. The heaters *A* and *B* are used for drying clothes in a steam laundry. The blow-off of the boiler is about 4 feet from the ground, and the heater *B* is placed on the ground and both are 4 feet high. The steam enters in the top and passes through the pipes to the bottom and then out of the discharge pipe. One of the heaters is made up of 1¼-inch pipe, the other of 1-inch pipe, both discharging into a 1-inch pipe. The discharge pipe goes through the wall and up above the roof, making the riser about 24 feet high. On the end of the riser I have a return bend and an ell; then a horizontal pipe 11 feet long, having an elbow and a straight drop down to the blow-off pipe, through check and globe valves to the boiler. The pipe running down to the blow-off pipe is about 16 feet above the water line in the boiler.

Now, if my theory is correct, there is between six or seven pounds pressure on that pipe, which should be sufficient, but it fails to force the water into the boiler. Who can explain the trouble?

F. H. BEARD.

Lorain, O.

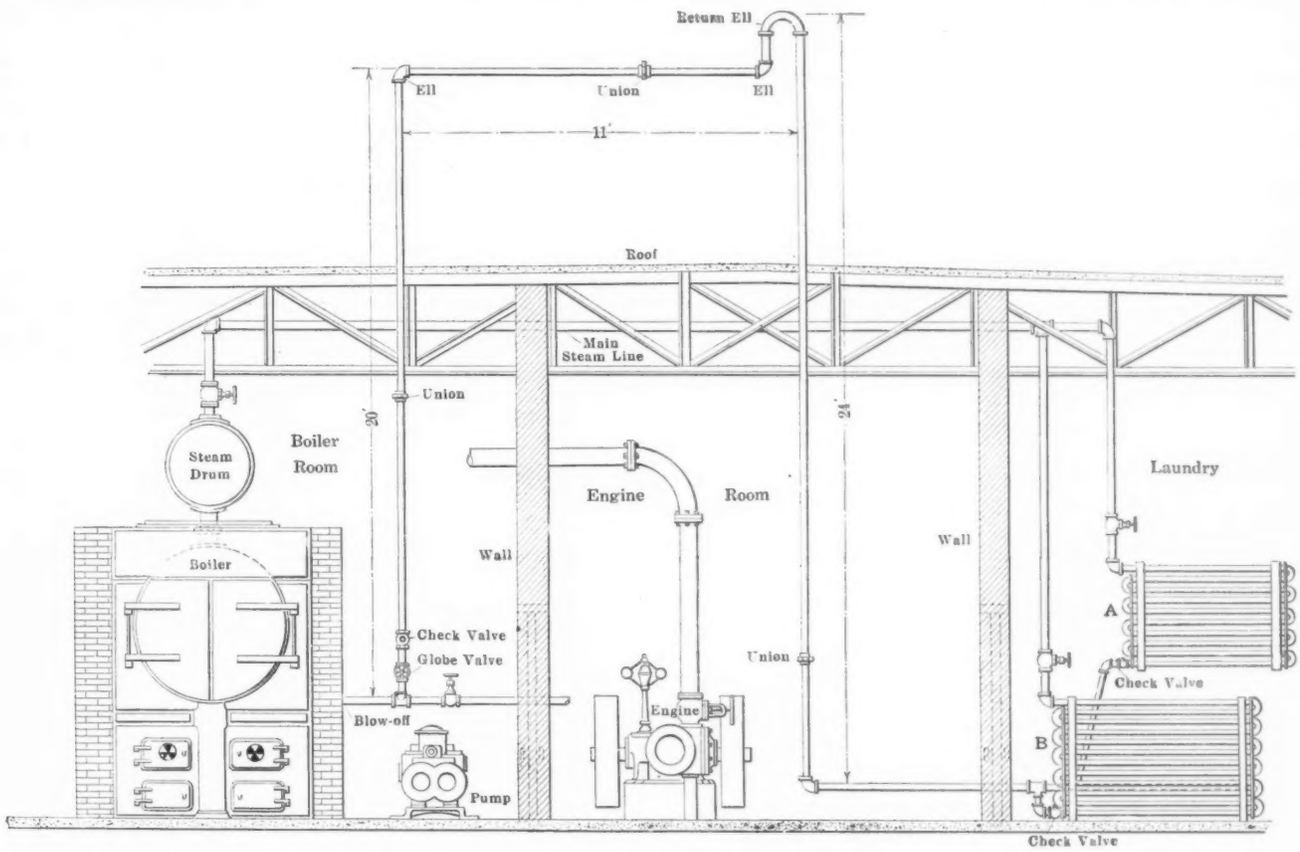
Cause of Leaky Tubes

In June 30 issue, page 1038, Mr. Eckley gives some of his experience with boiler compounds. I do not agree with him when he says that compound put into a badly scaled boiler will necessarily cause it to leak, but such is frequently the case. This is beneficial rather than otherwise, because it shows that the seams and tubes have been kept from leaking by the layer of scale next to the shell. If scale is holding your boiler together the boiler compound is doing good service in showing up its weakness.

Boiler compound is frequently blamed for causing leaky tubes when it is not so much to blame as the man who put in the tubes in the first place. The holes in the tube sheet do not get any smaller with repeated rolling, and each time a tube is rolled the expander makes the hole a little larger than it was before. I replaced forty-six 3½-inch tubes in an 80-horse-power boiler at one time, some of which required a thimble ⅛ inch in thickness to fill the hole in the sheet. In similar cases I have seen men, who ought to have known better, drive the pin into the roller and roll until the tube was finally expanded enough to fill the space. Such a tube nearly always gives trouble by leaking. The fit is a tapered one, so far as the tube is concerned, and the metal of the tube is stretched beyond the elastic limit, so that its ability to expand and contract with heat and cold is impaired before its work has begun. This may not have been the case with the 6-horse-power boiler Mr. Eckley speaks of, but it has been the cause of several leaky boilers which have come under my observation.

To give a boiler compound a fair trial, it should be tried on a clean boiler, or if on a badly scaled boiler, any leaks should be repaired, not stopped, and then the use of the compound kept up until it was definitely proved to be useful or otherwise.

Engineers have often commented on grooving in the shells of return-tubular boilers. I have never seen many cases of it, but what few I have seen could be traced to the presence of free acids in the feed-water, or some substance such as magnesium chloride, for example, which liberates its acid readily. In either case the use of zinc is attended with good results, the action being chemical rather than electrolytic, although with magnesium chloride it is difficult to remedy grooving in any way; the addition of iron turnings or borings to the filtering chamber of the feed-water heater has been suggested, and it looks feasible, but I do not know of anyone trying it.



SHOWING ARRANGEMENT OF STEAM LOOP

Coffee, potatoes, sugar and various other organic substances have been suggested as exerting a beneficial influence on scale-forming matter in a boiler.

LE ROY BAKER.

St. Louis, Mo.

Setting of Steam Eccentrics

Recently I have had a time with an engine with steam eccentrics set at 60 degrees ahead of the crank. This is a 18 and 36 by 42-inch Corliss, direct-connected to an alternator, and a wheel on the shaft belted to line shafting in the factory. The specification for the engine called for the steam valves on the high-pressure side to be set at 1/16-inch lead, and on the low-pressure at ⅜-inch, the wrist plates to be vertical and the eccentrics placed at an angle of 90 degrees to the crank.

The specifications were drawn up by a practical engineer, and after prices were all in, the job was turned over to a contracting firm which employs mechanical engineers who were brought up to set up dynamos and do wiring. The dynamo mechanical engineer, who had charge of the job at the time, told the engine builder that he need pay no attention to the specifications but go ahead and build the engine as he chose. This man then cleared out and it was left to another dynamo mechanical engineer to put the machine in. This latter man superintended the putting up of the apparatus, pronounced it all right and had the purchaser pay for the machine.

When I came to look the job over, there were several things that seemed to me very much out, but there were two things especially so. The exhaust on the low-pressure side was very slow and the pressure did not get entirely out until nearly the full stroke had been completed. Also, there was no regulation. Steam would not follow farther than ⅜ of an inch, and when steam was carried, to have the cut-off shorter than this, the governor struck and would not regulate closely. This trouble was located in the different joints, and after five of them had been refitted that part was all right.

As to the short range of cutting-off, I found that instead of setting the eccentrics at 90 degrees to the crank they were set at 60 degrees. Now, when eccentrics are set at 60 degrees the trips must be set so that the valves always trip; because, if left to hang on when the governor was down they would be open way past the counter and steam would blow through so strongly that it would not be possible to start. It was this thing that mixed things up in the cutting-off line, as the rod from the governor to the trips had been shortened too much and the range of cut-off made as short as with a single-eccentric engine.

There is no way to tell when running, nor when stopping and starting, without going all over the engine. This is one of the points against the 60 degrees arrangement, as an assistant may "monkey" with the setting without being detected. This has been done in my practice. In this case I ran the engine slowly and lengthened the governor connection until the valves would just trip.

There was another thing that setting

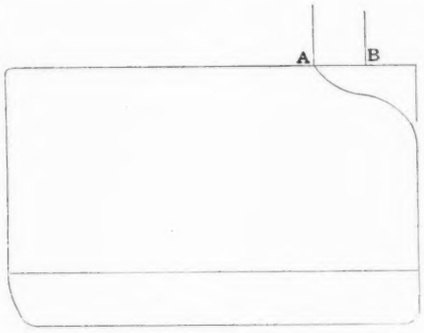


FIG. 1

the eccentrics at 60 degrees makes inconvenient: the engine cannot be worked by hand as but one valve is hooked on. In order to hook on the other one to reverse, you must throw over the wrist plate, thus opening the steam valve wide at the instant you want to close it. It is true it unhooks after the engine has got the impetus from the wide-open valve, but you want to stop and you

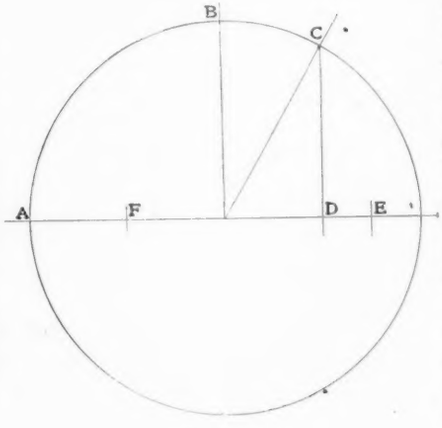


FIG. 2

can't do it. In this case, they have to let the engine stop where it happens to be and then they pull it around with chain blocks when they want to lace a belt, or get it in any particular place. It is convenient, when it is wanted to locate looseness in any part of the engine, to give it a little steam and throw it back and forth on both sides of the pistons. You can't do that with the 60 degrees setting.

Unfortunately this engine is made by a firm which drills two holes into the shaft and bolts the eccentric to the shaft, and if you want to change an eccentric very much, you have to drill new holes, and I don't want to drill a ring of holes around the shaft on the end that is carrying the heavy fly-wheel and a large part of the revolving field. Were it an ordinary eccentric, I could shove it around to the 90 degrees and respline the valve stems and put the engine into shape so that they could handle it.

Another thing, it is very inconvenient for warming up. The excuse for this montrosity is that they want to get a long range of cutting-off and they claim to get a range of from ¾ to ⅞. Such a thing is nice in rolling-mill work and on peak electric loads.

Let us look at it a moment. To get steam out of a cylinder running at modern speed, it is necessary to have the exhaust open at or before ⅛ stroke from the exhaust end, so that ⅞ stroke or beyond means throwing steam into the exhaust. On the diagram, Fig. 1, *A* is ¾ stroke and *B* is ⅞, or ⅛ from the end, and the opening of the exhaust. Of what value is the area shown from *A* to *B*, when there is a possibility of losing some of the steam into the exhaust at *B*.

Take the diagram, Fig. 2: Setting the eccentric at 90 degrees to the crank, it is possible for the steam to follow the piston while the crank pin is traveling from *A* to *B*, or half stroke, and the cut-off must take place previous to this.

The first steam eccentric set this way was in rolling-mill work twenty-four years ago and diagrams were taken with heavy loads showing that although the cut-off took place at or before half stroke, owing to the high speed at which the piston travels at the center of the stroke, the valve did not get closed, so that steam was not shut off until three-quarter stroke. Other rolling-mill engines since that time have shown the same thing, as well as peak loads on electric engines.

With an eccentric set at 60 degrees, the crank will travel from *A* to *C*, or three-quarter stroke of the piston, to *D*, and *E* is ⅞ stroke, or the point where the exhaust should open. When the piston is near either center it is at so slow a speed that the valve, having but a short distance to travel, will close so as to shut off the steam at about the point occupied by the piston at the time and the variation will increase as the piston increases in speed.

With the eccentric set at 60 degrees, both valves can be left hooked on at the time the governor is at its lowest point, the engine can be worked by hand for all purposes. Setting all wrist plates vertical, as the steam valves have 1/16 inch lead and the exhaust ⅛-inch, by

simply opening the throttle the steam blows through both ends of the cylinder, and, if compound, through both cylinders and through the receiver, thus warming up a cold engine quickly and thoroughly.

There are those who argue that when an engine cuts off it cuts off; that is all there is to it; that if it cuts off at half stroke it is half stroke and not three-quarters; that it is not possible for steam to follow a piston after the valve has tripped; and that the piston does not advance during the closing of the valve. There are those who have had experience with eccentrics set at 90 degrees with heavy peak loads, who have long been familiar with getting diagrams showing three-quarter cutting-off. With the eccentric set at 60 degrees and the valve not tripping until three-quarter stroke, shown on the diagram at *A* and on Fig. 2 at *C*, the piston has got to a point where it is showing up and may not travel farther than from *D* to *E*, Fig. 2, while the valve is closing. If it did it would blow into the exhaust.

Is the filling of the diagram from *A* to *B* worth all the inconvenience made by setting a steam eccentric at 60 degrees, especially on engines that never will under any conditions be called upon to follow three-quarter stroke and probably never more than half-stroke?

The owners of the engine mentioned at the commencement of this letter would be pleased if their steam eccentrics could be set at 90 degrees and do away with all the annoyances and delays caused by the 60 degrees arrangement.

W. E. CRANE.

Waterbury, Conn.

Protection of Life and Employers' Responsibility

Having in mind the awful accident which happened on the cruiser "Tennessee," I am prompted to call attention to the almost criminal negligence of large corporations and like interests, in regard to the protection of life in their engine and fire rooms. Almost 100 per cent. of these accidents could be prevented if the proper safety appliances were placed on the boilers and steam pipes. They are obtainable and known to the users of steam power, but yet there appears to be but the slightest effort made to stop or prevent accident. Human life and property are surrounded by all manner of safety devices except in the engine and boiler rooms. It is appalling to see the records of the loss of life and property in the past fifteen years, due to the bursting of steam pipes, cylinders and fly-wheels.

PETER BARCLAY

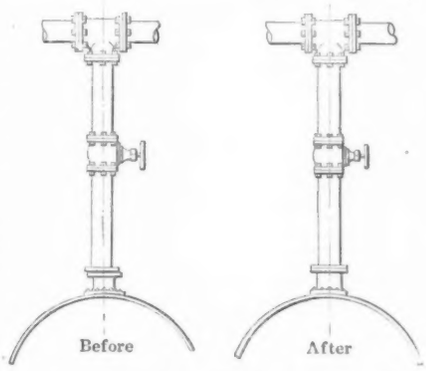
Boston, Mass.

Mismeasurements

When piping is placed in position, no matter for what purpose, the conditions must be considered. Much more is required than making up joints to stay in place merely until the first cost is figured.

In a central power station ten horizontal boilers were installed, one of which gave trouble from the start, and continued to do so for two years, by blowing out gaskets between the nozzle flanges. These had been replaced time and again with different kinds of packing, but always with the same results. I was asked if I could suggest some plan for relief.

I found a horizontal pipe running centrally over the nozzles, each riser being flanged to a tee. When the bolts were being removed from the flanges, it was noticed that a severe shearing strain was being exerted upon them, so much so that the bolts on the upper flange were slacked off a full thread before the lower ones could be removed by hand. I was told that a jack had to be used to bring the holes in line and that boiler pressure was carried in the pipes at the time.



CORRECTING THE EFFECTS OF MISMEASUREMENT

After the riser was removed a level was placed on the nozzle flange, which showed it to be out of horizontal plane 3/16 of an inch. On dropping a plumb line from the center of the tee, the first error was aggravated by an ⅛-inch short measurement. A set of extra-heavy flanges was procured, and each flange was planed off from ¼ inch to zero, and screwed on so that a throw was given the riser without strain and bringing the flanges face to face. A gasket of ⅛-inch standard sheet packing was placed between each set of flanges and no more trouble was experienced in holding the joint. The condition of the piping before and after the job is shown in the illustration.

Mismeasurements may be due to faulty instruments. There is, however, an abundance of standard instruments, all inexpensive and essential to good work. Many of these can be made in spare moments, to answer the purpose as well as those purchased. One especially useful in measuring under 10 feet is a sliding set of 5-foot rods, adjusted by a thumb-screw. It can be carried to the bench with no chance of error creeping in.

The new 4- and 6-foot rules are very handy, but they cannot be depended on for accurate measurements and should be used only for rough estimates. The line, bevel, plumb, sliding pole, square, etc., each in the right place and at the proper time, will never be regretted for the few moments taken in precaution.

Very few men employed as pipers on plants by the week are competent workmen in the sense of perception or discernment. If a measure of 45 degrees were to be made, the probability of the pipe fitting would be remote.

W. T. CROWELL.

Winsted, Conn.

Circulation of Water in a Tubular Boiler

The hottest place in a tubular boiler is directly over the fire. The water will rise from the hottest part of the shell and cooler water will take its place; so it is plain that as the water rises from over the furnace, water from the rear end takes its place, because the water in the rear end is cooler than that which rises to the top from over the fire. The hotter water will circulate toward the point from which the cooler water comes; that is, the water rises from the bottom at the front end and flows along the top to the rear end, down between the tubes to the bottom, and along the bottom to the front end.

One of the reasons for claiming that this is the direction of circulation is that when one opens a boiler to clean it, he will find most of the sediment piled up in the front end. If the circulation were from front to rear, along the bottom, this sediment would not pile up in the front end, but would be carried to the rear end; and as the sides of the shell are hotter than the tubes, the water will flow from the sides to the center of the boiler.

As nobody is able to see which way the water is circulating when the generation of steam is taking place within the boiler, I consider the following a very good way to convince oneself: After cleaning the boiler, fill it with water to the proper level and leave the top manhole open. Fire up as usual, until the water starts to boil, then get some small blocks of pine, or other lightwood, and throw them into the front end of the boiler. It will only be a few minutes before the blocks will be floating along the center of the boiler toward the rear end, and when they reach the rear end they will stay there. The water flowing from the sides to the center keeps the blocks from floating to the sides, and the water flowing from the front to the rear carries the blocks with it.

W. H. STIVASON.

Wilson, Penn.

Is This Perpetual Motion?

Your correspondent, Mr. Benkendorf, in the June 23 issue, can easily solve this problem he makes on page 996, by the application of the principle of equilibrium, viz, that in any system of bodies free to move, the tendency is to seek that position in which the center of gravity is lowest, and to come to rest there.

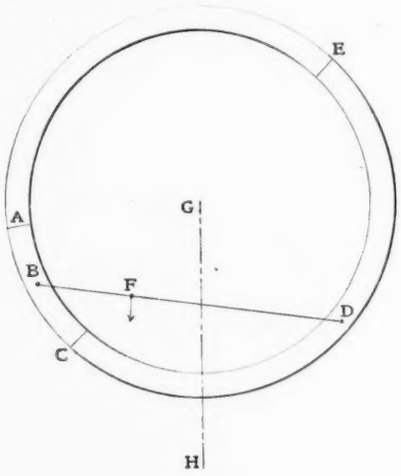


FIG. 1

The center of gravity of the hollow ring is at its center, and the ring has no tendency of itself to move on a horizontal surface. The centers of gravity of the water and mercury cannot, however, be at the center of the ring, but in the position shown may be to the right of the vertical line passing through the center of the ring. To find the position of the mercury and water when the ring is at rest, find the position of the center of gravity of the water and mercury combined; then the ring will roll until this is vertically below the center of the ring.

It will be an exercise for Mr. Benkendorf's mathematics to find how much mercury and water will have to be introduced into the ring so that the water just does not flow over the top when the ring is at rest.

G. J. WELLS.

Dumfries, Scotland.

Regarding the query in the June 23 number as to whether mercury will unbalance the water, or *vice versa*, and produce motion, it requires no hesitation to say that there will be no motion produced, for the following reasons:

Calling B the center of gravity of the mercury column $A\,B\,C$, and D the center of gravity of the water column $C\,D\,E$, then the center of gravity of both will be at F on a line between the two.

Now, to start, we shall assume that F is at one side or the other of the vertical $G\,H$, Fig. 1. What will happen? he fluids will merely move around until F is directly in the vertical, and there will be absolutely no tendency for further motion and F will be stationary as per Fig. 2.

J. E. FULWEILER.

New York.

Under the title, "Is This Perpetual Motion?" in the June 23 number, O. A. Benkendorf describes a ring containing mercury and water, and asks if the mercury will unbalance the water, or will the water unbalance the mercury?

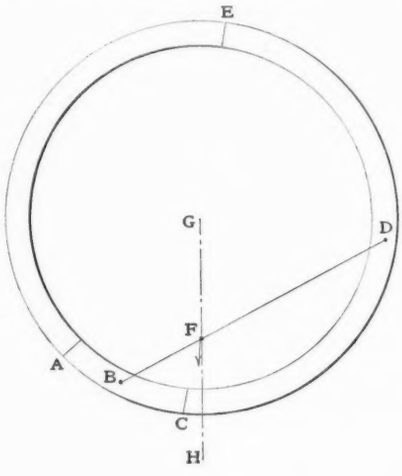


FIG. 2

The mercury will certainly be raised on the side X in proportion to the amount of water added at Y, the specific gravity of mercury at 60 degrees temperature Fahrenheit being 13.58. The weight of the two columns will immediately be equalized and there will be no motion produced in the ring.

H. J. MCCARTHY.

St. Paul, Minn.

What Caused the Pound

In answer to William McCann's inquiry on page 151 of the July number, I find upon going over his diagrams that the left-hand one does not show any clearance, which would indicate that the piston came in contact with the head of the cylinder. He did not mark his diagrams, but I take it that the left-hand one is for the crank end. It also appears that the exhaust port closes about 4 inches earlier than the other end; so I think that if Mr. McCann will divide the clearance in the cylinder and close the ports at the same distance from the ends, the pound, or some of it at least, will disappear.

WILLIAM HOUSE.

New York City.

A Flywheel Oil Guard

With many engines there is a tendency for oil to work out from the bearings or eccentrics along the shaft to the flywheel, when the centrifugal force throws it off to lodge on anything in line with the wheel. In some cases the amount of the oil is sufficient to cause much annoyance and, perhaps, actual damage. Switchboards especially suffer by being spattered with oil and present an unsightly appearance. The sketch represents a shield, or guard which will protect anything in front of the wheel. The frame is of angle iron and the foot piece and brace of slab iron. The shield may be of tin, stove-pipe iron or russia iron, the latter presenting the best appearance. Fig. 1 shows it as it is when looking toward the face of the wheel, and Fig. 2 as it appears when looking toward the side.

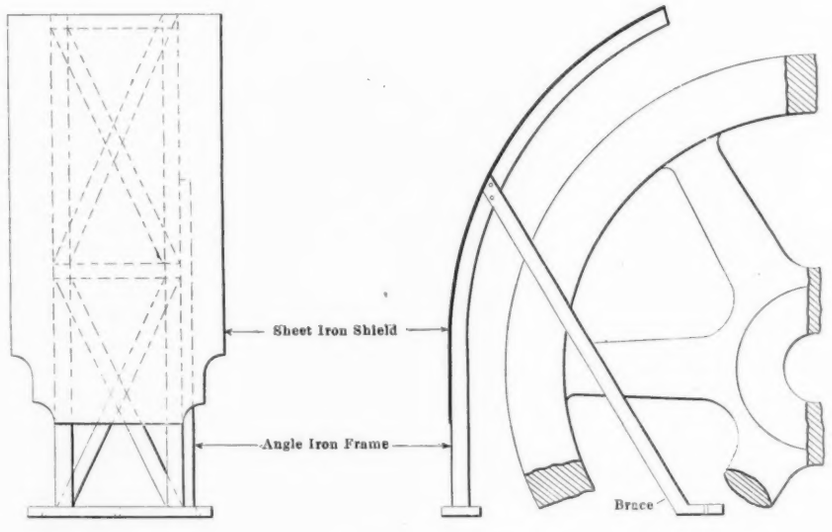


FIG. 1 A FLYWHEEL OIL GUARD FIG. 2

If the engine drives a direct-connected

generator a short brace may be run from the frame of the shield to the generator frame, thereby making it more steady. The shield should be considerably wider than the face of the wheel and set as close to the wheel as is safe.

C. L. GREER.

Handley, Texas.

Burning Wood and Sawdust

When I took charge of a locomotive-type boiler in a sawmill, the grates were about half burnt out, and as the mill was in the "backwoods" we had no more to take their place. I found it impossible to keep up steam for any length of time, so by laying the remaining grates along the center of the fire-box and filling in the vacant space with bricks, I found that by using sawdust and piling it along the sides of the fire-box, leaving a space bare along the center of the grates, I could keep up steam all right. See Fig. 1. I used this plan for about five months before we got a set of new grates. The new grates were supposed to be for burning sawdust, but I could never get as good results from them as I did with my emergency outfit. I have often thought since that it would be a good plan to try this scheme in a furnace of a bricked-in boiler (Fig. 2) where the sawdust is brought in by a conveyer.

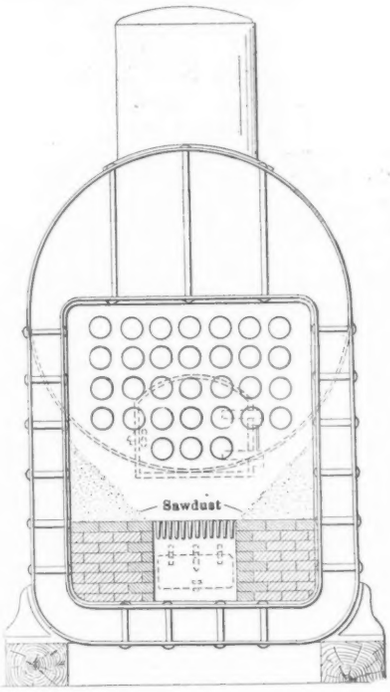


FIG. 1. SECTION THROUGH LOCOMOTIVE FIREBOX

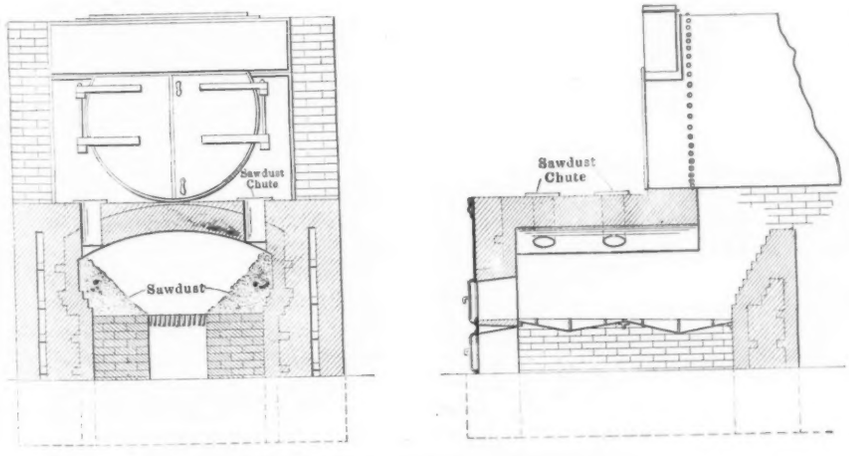


FIG. 2. PROPOSED PLAN FOR BRICKED-IN BOILER

A. J. FERGUSON.

Arrowhead, B. C.

Receiver Pressure, Lead and Compression

I have read your editorials appearing in the July 14 issue, with considerable interest, particularly those relating to "Receiver Pressure" and "Lead and Compression." In the first one referred to, you leave little, if any, doubt as to just what should be done when making valve adjustments for receiver pressure in compound engines. I tried the same method some few years ago on a number of tandem compound-condensing engines, for street-railway power purposes, and found as a result that the engines did their work more economically than before the change was made.

We took one of the engines that was in pretty good condition, and had the switchboard man handle the rheostats so that as steady a load as possible was carried by the engine. Indicator diagrams were then taken from both cylinders without changing any of the conditions that the engine had been operating under. The boiler pressure was 140 pounds (gage), and the receiver pressure, the same as always carried, was from 12 to 15 pounds (gage). The diagrams taken under these conditions, with the load that the engine was to carry for the greater part of the time, showed that the terminal pressure in the low-pressure cylinder was about 12 pounds absolute—a little higher than I thought it should be when economy is considered.

With the load practically kept constant, we began increasing the receiver pressure, taking diagrams after each increase of pressure, until at 25 pounds gage pressure we obtained a terminal pressure in the low-pressure cylinder of about 6 pounds, absolute, which was as low as I cared to have it at that time. All the engines were changed in the same way with the result that with the change, with some others that were made in various parts of the plant as a whole, the steam consumption was decreased from what it originally had been.

Increasing the receiver pressure meant increased initial pressure in the low-pressure cylinder, and increased back pressure in the high-pressure cylinder, and consequently the mean effective pressure in the high-pressure cylinder was reduced by so doing, but the mean effective pressure was increased in the low-pressure cylinder. This increased pressure in the low-pressure cylinder had a tendency to make the engine run faster and so the governor weights rotated in a higher plane than they did at first, the load remaining the same in both cases. The higher governor position undoubtedly explains the cause of the lower terminal pressure in the low-pressure cylinder, and also the decreased steam consumption, the load remaining the same, as before stated.

We therefore decided upon carrying 25 pounds (gage) receiver pressure on all the engines in order to suit the load each carried for the greater part of the twenty-four hours, and this without regard as to which cylinder was doing the most work. Of course, for some other load, being either greater or less, 25 pounds receiver pressure might not be the most economical pressure to carry, as is to be inferred from your editorial in question. In relation to this matter it must be remembered, that making an engine carry a given load in the most economical manner, and making a load to be the same as that for which the engine was designed to be the most economical, is two different and distinct things. When this is understood and remembered, there is little wonder that men disagree about receiver pressures, points of cut-off, etc. Each party in an argument may be right, from his own viewpoint and attendant conditions, yet each thinks the other is wrong, and wonders why he cannot see that he is wrong.

Concerning the editorial, "Lead and Compression," I would say that I have in past years tested the matter on several engines, particularly Corliss compound-condensing engines, operating at from 60 to 90 revolutions per minute, and found that by reducing both lead and compression to a minimum, the engines did bet-

ter work mechanically and economically. By the expression, "to a minimum," I mean that I adjusted the valves so that when the crank was on the center and the piston just about to move on its stroke, the valve was open about as small an amount as could be determined when comparing the marks that are on the ends of the valves and chambers as obtains in Corliss engines. If asked to give a definite figure I would say 1/32 inch for the high-pressure cylinder, and for the low-pressure cylinder a little more, according as to how well the pressure kept up in the receiver.

For compression, close the exhaust valves just a little before the steam valve opens, so that the exhaust valve will lap the port sufficiently to prevent the escape of the incoming live steam. These things have been tried by me, and in my particular cases, economy and smooth running has been the result. I cannot go so far as to say that the same practice would do upon *all* engines, but I think it would upon *many* that are not so adjusted.

CHARLES J. MASON.

Scranton, Penn.

Multiple Stacks Gave Trouble

About two years ago the factory in which a friend was employed was enlarged and among other alterations it was proposed to build a new boiler and engine house. The site was selected and in due time the building was finished. Of course, the location of the boilers was a matter of very little importance, as it usually is, any old place being good enough for boilers. Accordingly a large hole was dug, the sides of which were built up with stone, thus forming a boiler cellar, for that is the best name to apply to it.

The outfit of the old plant consisted of two return-tubular boilers, 54 inches in diameter by 16 feet long, connected to a 32-inch stack 60 feet high. These boilers were removed to the new site and two additional second-hand return-tubular boilers 60 inches in diameter by 20 feet long, were procured. All four of the boilers were set in the boiler cellar or subway. The ash-pits were about seven feet below the surface of the ground, which was bad to begin with. The stack had been in use about 10 years and was pretty well rusted out, holes being visible, but it was decided to paint it up and utilize it, as a few holes did not make much difference. Two new iron stacks were built to correspond with the old one in appearance. The new stacks were approximately the same size as the old, 32 inches in diameter by 60 feet high. A brick base was built up to the level of the boiler-house wall, on top of which was placed an iron base-plate to receive the three stacks, as indicated in Fig. 1. A flue was constructed to connect the stacks with the boilers. It was decided that this flue could be constructed out of heavy sheet iron, the work being done by the all-round man of the place. When the base of the stacks was built it was expected to have two round flues, therefore, two holes were left in the wall to receive them, as shown in Fig. 2. This plan was changed later to a square, home-made design. When the handy man proceeded to measure for the flue he found that the safety valve of the outside boiler nearest the stacks was directly in front of one of the openings in the base. He decided he would build around it, as shown by the dotted lines. This was done, and after a time the flue was completed and the boilers fired up. From what I have heard they did not know that they had a flue at all.

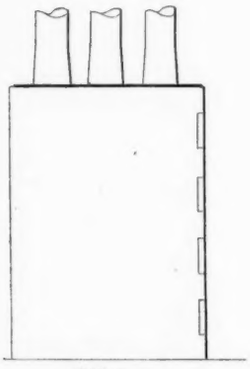


FIG. 1

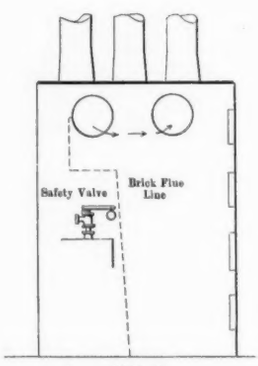


FIG. 2

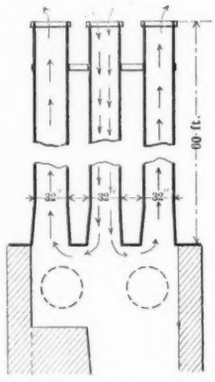


FIG. 3

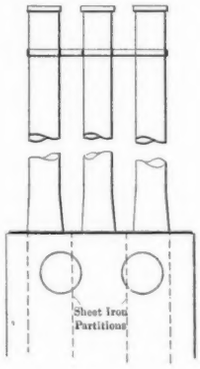


FIG. 4

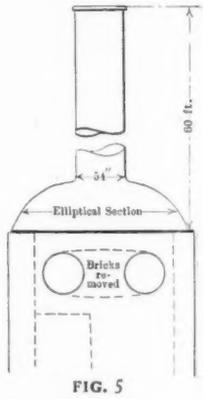


FIG. 5

Large volumes of smoke poured from the ash-pit and furnace doors, accompanied at times by back draft which made it rather dangerous for the fireman standing in front of the furnace, to say nothing of the inability to raise steam. After considerable trouble steam was raised to the necessary pressure, but as soon as the engines were started down came the steam again. Of course, the fireman came in for a full share of the blame, and was finally discharged as incompetent. Another was engaged only to receive in a short time the fate of his predecessor, and still more came and went, until it seemed to be impossible to obtain a fireman.

One day while watching the stacks, the engineer noticed that a comparatively small amount, and, at times, no smoke at all, came from the center stack. Upon going to the roof of the boiler house and placing his hand on it, he was surprised to find it quite cold, while the other two were hot, one being hotter than the other. Upon investigating he found that instead of coming from the furnaces through the tubes to the stack, the currents of air were coming down the center stack and passing up the outside stacks, as shown in Fig. 3. This appeared to account for not getting any draft. A number of sheets of iron were then procured with which to partition off the base of the stacks, as shown by the dotted lines in Fig. 4. Still the boilers worked no better than before. It was then discovered that the circulation was around the center of the brickwork between the two holes in the base, as shown in Fig. 2. More sheet iron was procured and the flue was partitioned off in sections, so that each section received the benefit of one stack. This improved matters somewhat, but the results were not what they ought to have been, because the joints were not made with any degree of tightness, the soot seal being relied upon to finish the job.

It was finally decided to take down the three stacks and erect one large one in their place. A 54-inch by 60-foot iron stack was built, with an elliptical base, as shown in Fig. 5, so as to take in the three openings in the base-plate. The sheet-iron partitions were removed and another trial made. The conditions were a good deal improved, but still the result was far from satisfactory. They had a good deal more draft, but a steam jet had to be employed to attain the desired results at a great waste of steam. One day, while the flue was being cleaned, the engineer got into the flue to investigate the conditions. He had the bricks from the center of the openings removed, thus making a large elliptical opening. When the boilers were fired up the next day, it was found that the problem was solved, the draft being in every way satisfactory.

The only explanation to be given of the last trouble is that it is an established fact that water or air will not go around corners, if it can go direct, and as one opening in the base of the stack was partly

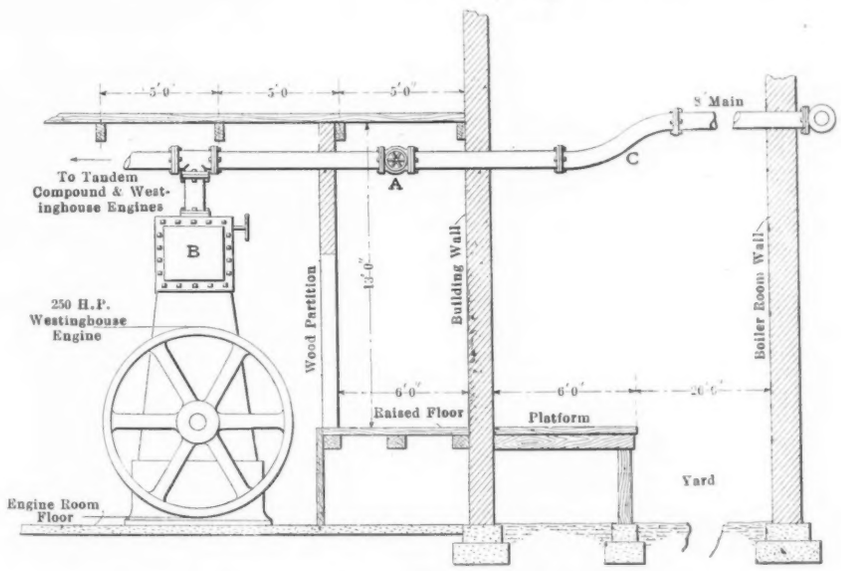
cut off by its being in front of the safety valve and the flue built around it, the draft naturally sought the first and most direct opening, notwithstanding that the area was decidedly less than the combined area of the tubes. This small area put a check on the draft. The foregoing proves that any firm which contemplates making extensive alterations, will do well to consult a good practical man and get his ideas on the subject.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Valve Broken Through Neglect

During a four-day shut-down we had occasion to shut off an 8-inch horse-power steam main. The accompanying sketch shows the arrangement of the piping. The engine, valve *A* and piping had been installed two weeks previous to this shut-down. This 8-inch main also supplied two other engines.



ARRANGEMENT OF PIPING FORMING WATER POCKET

Previous to the installation of the valve *A* it was necessary to shut off the valves leading from each boiler in order to shut off this main. It happened at the time of the shut-down that we were making repairs on the receiver for the tandem-compound engine, and it was, therefore, necessary to shut the valve *A*.

On Sunday, the last day of the shut-down, after completing all repairs we turned on the steam to test and be in readiness for the morrow. As the valve was opened slowly we heard considerable crackling and hammering. Unmindful of that, the man at the valve opened it more, the noises increasing until suddenly there was a loud report and steam and water spurted out, filling the engine room. After the valves in the boiler room were closed, we found a piece broken out of the bonnet of the valve about 6 inches square. Of course it was necessary to take the valve down at once and replace it with something else. I took the necessary measurements for a spool piece, and fortunately soon communicated with a firm who could furnish us a spool piece that, with a little machining, would fill our requirements.

The direct cause of the break was due to water accumulating at the valve, due to the 2-foot drop in the pipe at *C* which, with the action of steam, caused water hammer. We carried from 140 to 200 pounds pressure on this main.

Had we installed a by-pass it would have taken care of the water by means of a drip pocket installed for that purpose. It was purely a case of neglect.

WALTER J. BITTERLICH.

Roxbury, Mass.

Comments on Turbine Operation

In H. R. Mason's "Comments on Turbine Operation," on page 1018, of the June 30 number, he gives some good points on the handling of turbine units in his station. Turbines, being of comparatively recent adoption, many operating engineers have obtained their experience with them from the units installed in one station only; whereas, their engine experience usually covers several plants, with their different conditions. From figures given by Mr. Mason, all these are emergency starts and he loses sight of the fact that the time I stated was for every-day running and *not* emergency starts. The waste of steam is not as great as one would think, in using our method of starting a Parsons turbine of 1500 kilowatts. For 10 minutes the bypass in the throttle is cracked just enough to allow a little steam to issue from the glands, then closed for 10 minutes, after which the turbine is turned slowly at approximately 10 to 15 per cent. of its speed. The only time when any amount of steam is used is when bringing up to speed. We usually take 5 minutes for this, including picking up water for the condenser and synchronizing. If the throttle leaks slightly, as is often the case, the turbine will remain warm enough to permit of turning over at once, if desired, thus cutting the time to about 20 minutes. This method practically eliminates severe vibrations with our turbine, whereas we always have considerable vibration if the time is shortened too much.

It is considered good practice to allow an engine unit of 1200 or 1500 horsepower to turn over slowly for approximately 15 minutes before it will be needed on the load; but we do not hesitate to put one of these units up to speed in approximately 1 minute, if an emergency calls for such a quick start. We do the same with our Curtis turbine of 500 kilowatts, without any sign of distress.

Mr. Mason cannot see the advantage of getting a turbine as hot as possible before putting it up to speed. He states that the temperature at the exhaust end must drop, when vacuum is obtainable, approximately as much as it is raised at the steam end when under load. A little reflection will show this to be incorrect, even with steam of ordinary temperature, and we are using superheat. I have frequently noted a temperature (with 160 pounds pressure) of 570 to 580 degrees at the turbine throttle. The maximum change at the exhaust end is from 212 degrees at atmospheric pressure to 102 degrees at 28-inch vacuum, a change of only 110 degrees. This should not affect it greatly. At the inlet end conditions are far different. Taking 150 to 200 degrees as the standing temperature, there is usually enough leakage to hold it at this. The temperature raises 570 or 580 degrees at times, under full-load conditions. This is a temperature difference of approximately 400 degrees and in the judgment of the operating engineers of our station, of which I am one, calls for moderation in starting this type of unit, in view of the fact that, the spindle, being hollow and comparatively light and admitting steam through it back of the dummy pistons, must heat up much more quickly than the casing, which contains a large mass of metal in contact with steam on one side only.

As we have four other units, we use these for emergency calls and give the Parsons a reasonable time for warming up, 20 minutes at least. This method prevents any objectionably vibration, whereas we do have vibration if it is put on more quickly.

F. M. VANDERVEER.

New Rochelle, N. Y.

Gages for Measuring Pressures of Liquids

Essential Features of Different Types, Including Liquid and Mercury Columns, and the Kind Used to Measure High Pressures

BY FRANKLIN VAN WINKLE

Gages employed for measuring the pressures of liquids are usually called piezometers. Any of the forms of pressure gages commonly used for indicating the pressure of steam, air or other fluids may be used for measuring the pressure exerted by water or other liquids. The commonest and also the most convenient forms of pressure gages are the Bourdon metal tube gage and the corrugated diaphragm gage, such as are ordinarily used on steam boilers. The dials may be laid off to give pressure in pounds per square inch, or head in feet, and water-works gages are frequently made to indicate both pressure in pounds per square inch and hight of water in feet laid off on the same dial, as shown in Fig. 1.

In gages of this kind there is no theoretical method of determining the amount of motion which the pointer should make for a given pressure. The location and values of the divisions can only be ascertained by tests in which known pressures

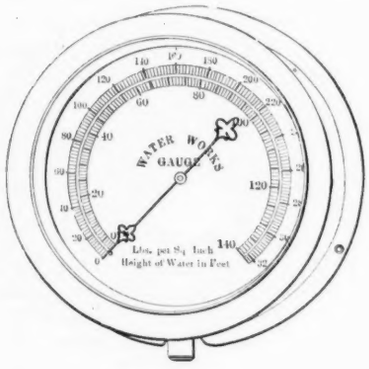


FIG. 1

are employed. It may also be said generally of metallic-spring gages that they are very liable to derangement when used with frequent or sudden fluctuations of pressure such as "hammering," which occurs in the force pipe of a pump, or when used at very high pressures. Metal-spring gages should, therefore, be compared with an accurate standard, both before and after use in any important tests or experiments.

Liquid Columns Most Reliable

The hight of a liquid column of pressure gages is indicative both of the hight or head of liquid pressing downward at the foot of the column and, incidentally, also of the degree of pressure created, as for instance, pounds pressure per square inch. Linear measurements of such hights may, therefore, be taken as representative of the pressure expressed either in inches or feet of hight of the column; or, knowing the density of the liquid of the column, the lineal hight may be taken as representative of pressure in pounds per square inch. Liquid columns are, therefore, not only preferable for use as standards of liquid pressure, but also because they are the most reliable of pressure gages.

If, for instance, it is desired to ascertain the pressure in the water pipe $A\,B$, Fig. 2, it may be done by employment of the ordinary metallic-spring gage S, or by directly connecting a vertical pipe D, terminating in a glass tube $F\,C$, to show the hight to which the water rises. The distance to be measured is the vertical distance from the center of $A\,B$ up to F. It is not essential that the tube itself shall be vertical. In fact, it is common in practice to connect a short glass tube $G\,H$ to the pressure point by means of a rubber hose H. In either case the vertical distance to be measured will be the same, i.e., to the upper surface of the liquid column. If there is any flow through the pipe $A\,B$, then the connections should be at right angles to the interior surface, for if they are inclined toward or against the current, the pressure will be greater or less than the actual pressure on the inner surface of $A\,B$.

If the columns are of water, then each foot of head would create a downward pressure of 0.434 pound per square inch and would be holding down an upward pressure of the same intensity. One pound pressure per square inch would, therefore, be represented by a hight of water column of

$$\frac{1}{0.434} = 2.304$$

feet, or 27.648 inches. As 27.648 inches in hight of water column is required per pound pressure, then 1 inch hight of water column will represent

$$\frac{1}{27.648} = 0.0361$$

pounds. When, however, it is desired to express pressure due to any given head or hight of water column in pounds per square inch, it is best to multiply the head in feet by 0.434.

Mercury-column Gages for High Pressure

In measuring heads under high pressures there are many situations in which it is impractical to employ the water-column gages on account of the great hight required, and hence mercury-column gages are used. Referring to Fig. 3, if $A\,B$ represents a column of water in one leg of the U-shaped tube $A\,B\,C\,D$, then the downward pressure created by it at B may be balanced by the upward pressure from a heavier liquid like mercury occupying the space $B\,C\,D$ and an additional portion $D\,E$ of the leg F. As B and D are at the same level, the pressure at B will be the same as at D. Pressure at D being due to the hight of the mercury column $D\,E$ above the level $B\,D$, the column $D\,E$ therefore affords a mercury column pressure for measurement of downward pressure at B. As mercury weighs 13.6

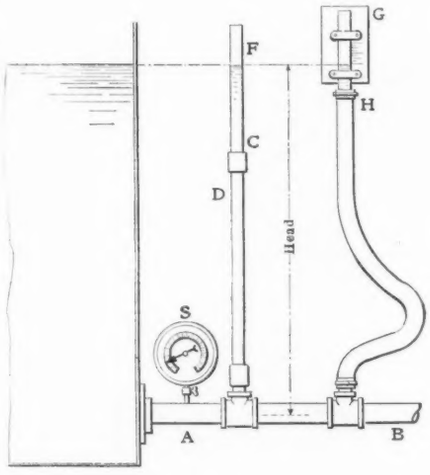


FIG. 2

times as much as water, each inch hight of mercury column $D\,E$ will balance 13.6 inches of the column $A\,B$. The mercury $B\,C\,D$ may be regarded as a balanced, frictionless plug or piston employed for transmitting pressure from one leg of the U-tube to the other.

The head or hight of a water column may, therefore, be expressed in inches of mercury column; each inch of mercury column, being equivalent to 13.6 inches or 1.133 feet head of water, would equal

$$1.133 \times 0.434 = 0.491722$$

pound pressure per square inch.

For general purposes, mercury U pressure gages are usually made of stout glass tubing in the form of a simple U-tube $A\,B\,C$, Fig. 4, secured to a board or other support. One upper end C is left open to

the atmosphere, while the other leg *A* is provided with a stop-cock *E* below which a flexible hose or rigid pipe connection *P* is made with the fluid whose pressure is to be measured. A scale, laid off in inches, is fixed between the tubes. Direct measurement of pressure "in inches of mercury" is made by taking the difference of readings on the scale; i.e., *W* and *H* being the respective levels of mercury, the value of the reading *W* is deducted from the value of the reading *H*. To eliminate errors due to unequal columns of water in the connecting pipe *P* and leg *A*, the cock *E* is provided for partially filling *A* with water before the pipe or hose *P* is connected to the vessel containing the water or other fluid whose pressure or head is to be determined. When reading the gage, *E* is closed, but to insure a solid column of water in *P*, the cock *E* should occasionally be opened

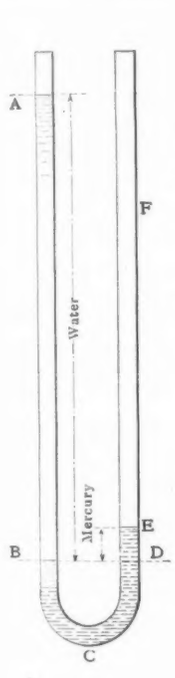


FIG. 3

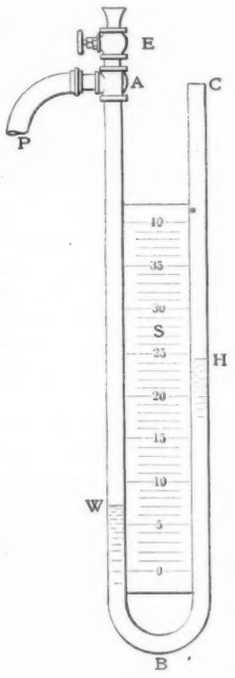


FIG. 4

slightly to permit the escape of air or other gases liberated by the liquid in *P*. The pressure measured will then be due to a head of water measured upwards from the level of the surface *W* of the mercury in the leg *A*.

Commercial Forms of Mercury Gage

Fig. 5 shows a portable form of a mercury piezometer used for determining the head or pressure in water mains. The upper end *A* is open to the atmosphere and through it mercury may be poured, the cock *B* being opened and *C* closed. Connection having been made to the water main by the hose or pipe *C D*, the air cock *B* is closed and *C* is opened. Water from the main is then admitted at *D*, and air is allowed to escape at *B*. Water from the main pressing the mercury down in the leg *E* causes it to rise in the leg *F*. The difference of levels at *E* and *F* is noted, and the hight of *E* above the main is also noted. The vertical distance *E* to *F* in inches, multiplied by 1.133, gives

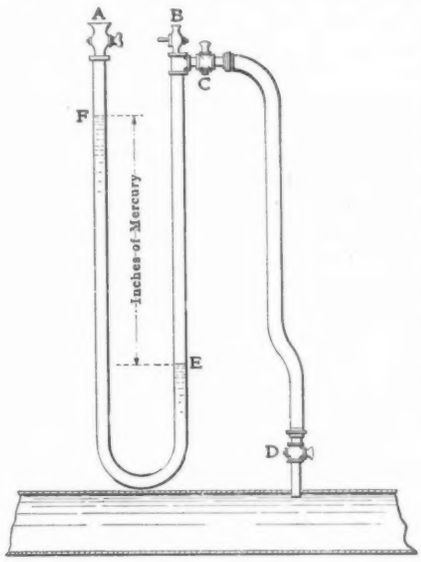


FIG. 5

the head in feet above *E*, to which we must add the hight of *E* above the main to obtain the actual head in feet of water pressure in the main.

When used for low pressures or pressures below that of the atmosphere, U-tube pressure gages are usually called manometers. Fig. 6 shows a commercial

FIG 6

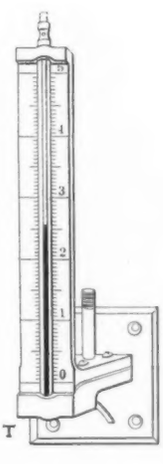


FIG. 7

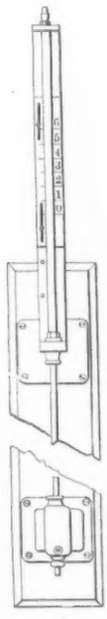


FIG. 8

form of manometer sold by gage makers for determining the pressure of illuminating gas. Two glass tubes joined together in the U-coupling *A* have a scale fastened between them which is laid off in inches and fractions above and below 0, to which point the tubes are to be filled with water. The brass siphon tube *S*, which is connected to one of the tubes at its upper end, may be screwed on any gas fixture in place of a gas burner. To determine the pressure, the difference of water level in the two tubes is read off in inches of water pressure, while *S* is connected.

A commercial form of stationary open mercury gage is shown in Fig. 7. The cast-iron trough *T*, containing mercury, has a pipe connection in its cover for receiving the pressure to be measured. A stout glass tube is mounted on a standard which is supported by the trough, forming a connection with the interior of the trough near its bottom. Pressure from a gas or liquid introduced on the top of the mercury in the trough forces it up the glass tube until balanced by the column of mercury in the tube. The scale is laid off in divisions to represent pounds pressure per square inch, or feet of head, or sometimes the gage is laid off in pounds

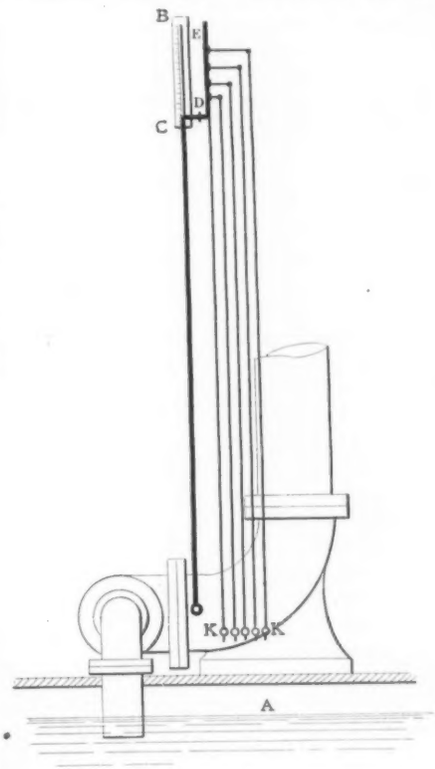


FIG. 9

per square inch on one side of the tube and feet of head on the other. When there is no pressure on the instrument, the column should stand at zero on the scale. If it does not, the level of the mercury in the trough can be raised or lowered by raising or lowering a screw which projects into the space occupied by the mercury.

Fig. 8 shows a form of open-end mercury-column gage used for indicating the hight of water in elevated tanks. Connection from the tank is made with the mercury well, shown in the lower part of the figure, in such manner as to introduce water from the tank on the surface of the mercury contained in the well, the mercury tube dipping well below the surface of the mercury. The scale shown in the

upper part of the figure may be laid off to indicate feet or inches of water in the tank. Mercury being taken as 13.6 times the density of water, each space on the scale corresponding to a foot hight of water would equal

$$\frac{12}{13.6} = 0.882$$

inch. The best practical method of laying off the divisions on the scale is to mark the standing of the mercury when indicating the highest and lowest levels of water in the tank, then to divide up the scale between those points into the same number of equally spaced divisions as there are feet of water to be measured.

For measuring pressure in different sections of closed flumes and penstocks of water-wheels where ordinary heads are employed, one or more open-end, vertical, water piezometer tubes are used. These, as shown in Fig. 9, are usually made up of steam pipe connected at the point where the pressure is to be determined, the upper end of the pipe being pieced out with glass tubing, through which the water level in the piezometer can be seen, and provided with a scale board laid off in feet and tenths of feet above the level of *A* or any other datum level.

An additional gage column *D E*, with side outlets located at known hights, is frequently employed where it is desired to make approximate determination of the standing of water in the piezometer without the inconvenience of going up to the elevation necessary to observe the scale *B C*. Each of these outlets has its separate discharge pipe carried down to a convenient point for opening the try-cocks *K K*.

Probably the highest mercury column ever used was employed by E. H. M. Amagat, who in 1880 worked with a column over one-fifth of a mile in hight. The actual hight of this column was 327 meters or about 1072.9 feet. By means of this column he was enabled to create and accurately measure pressures up to 6600 pounds per square inch. His experiments were undertaken to determine how the various gases, nitrogen, hydrogen, air, oxygen, etc., departed from Mariotte's law when subjected to great pressures. This enormous mercury column was erected in the shaft of a coal mine at Verpilleux, near St. Etienne, France. The mercury column was contained in steel tubing of about 5/8 inch diameter of bore and about 2 inches outside diameter, joined together in short lengths with special couplings and side outlets for determining the various hights of mercury column employed.

Measuring Enormous Pressures

For measuring very great pressures, the chief drawback with the simple mercury tube is the mechanical difficulty of constructing and using a sufficiently high column of mercury. Fig. 10 represents Desgoffe's manometer, a form of mercury gage constructed on the principle of the hydraulic press, though it may be said to operate in a directly opposite manner. The instrument is, in fact, employed to measure the enormous pressures reached in the cylinder of the hydraulic press and for other purposes where high pressures are to be measured. Fig. 10 gives a general view of one of these gages and Fig. 11 shows a sectional view of the principal parts. In these illustrations, *V* is a strong, circular, iron cylinder, with piston *D* and piston-rod *P* which acts as a plunger in the cylinder *C*. The lower part of *V* contains mercury, which has free communication with the vertical glass column *A*. The mercury is covered with a thin layer of water, and above that is a thin but strong rubber diaphragm, which is bolted down with an iron ring. The end of the plunger *P* moves water-tight in the cylinder *C*. The pipe *H* is connected to the vessel in which the pressure is to be measured.

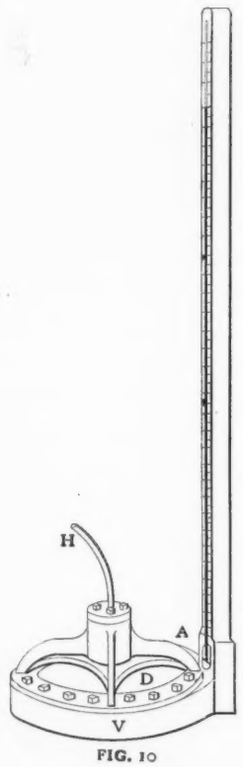


FIG. 10

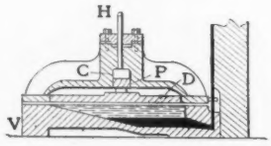


FIG. 11

Before pressure is admitted into *C*, the mercury in the glass tube stands at the lowest division of the scale *A*. Supposing the area of *P* to be 1/100 part of the area of the piston *D*, then the unit area of *P* will be sustained by 100 units of area of *D*. Consequently, each 100 pounds pressure per square inch on *P* will create only one pound pressure per square inch on *D* and the mercury contained in *V*. The mercury column *A* would therefore rise only 1/100 part as far as it would if directly attached to *H*. As 1 inch of mercury column balances 1.133 feet of water column in the same U-tube, neglecting the small amount of pressure required for depressing the diaphragm, a rise of mercury column of 1 inch would be equivalent to $1.133 \times 100 = 113.3$ feet of water column, while 10 inches would be equivalent to 1133.0 feet of water column. This, as we have seen, would be equivalent to

$$1133 \times 0.434 = 491.7$$

pounds pressure per square inch from the pipe *H*.

By making *D* very great in proportion to *P*, enormous pressures can be measured by a comparatively short column of mercury *A*. But from the fact that an error is introduced from the resistance offered by the rubber diaphragm and the difficulty of reading a mercury column closer than about 1/20 of an inch, instruments of this kind are not to be relied upon for determining pressure closer than the pressure indicated by 1/10 inch of the scale.

Steam and Coal Consumption of the "Lusitania"

In a paper presented to the Institution of Naval Engineers recently, Thomas Bell gave the following figures of the actual steam and coal consumption of the "Lusitania's" main and auxiliary engines at various speeds under conditions prevailing on official trials:

Auxiliary engines at various speeds under conditions prevailing on official trials, viz, turbo-generators exhausting to auxiliary condensers, other auxiliaries exhausting to heaters.

Shaft horsepower	13,400	20,500	33,000	48,000	68,850
Speed in knots	15.77	18.0	21.0	23.0	25.4
Total consumption of auxiliaries in lb. per hour	71,000	76,400	85,700	96,700	116,500
Total consumption of turbines in lb. per hour	284,500	353,600	493,300	668,300	879,500
Steam consumption of auxiliaries in lb. per H.P.-hour	5.3	3.72	2.6	2.01	1.69
Steam consumption of turbines in lb. per H.P.-hour	21.23	17.24	14.91	13.92	12.77
Total steam consumption in lb. per H.P.-hour	26.53	20.96	17.51	15.93	14.46
Temperature of feed water, deg.	200	200	199	179	165
Coal consumption in lb. per H.P.-hour	2.52	2.01	1.68	1.56	1.43
Estimated coal consumption in tons on a voyage of 3100 nautical miles, allowing 20 tons for galleys, etc	2,980	3,190	3,670	4,520	5,390

Another Flywheel Wreck

Early Saturday morning, Aug. 1, a 12-ton flywheel burst at the works of the North Adams Gas Light Company, North Adams, Mass. The wheel belonged to a 500-horsepower cross-compound condensing engine, making 135 revolutions per minute, and was 15 feet in diameter. For some reason not accounted for, the engine began to race, and before the emergency stop, which the engineer reached, could take effect, the wheel exploded, resulting in the damage shown in the accompanying illustrations, which is estimated at about $10,000.

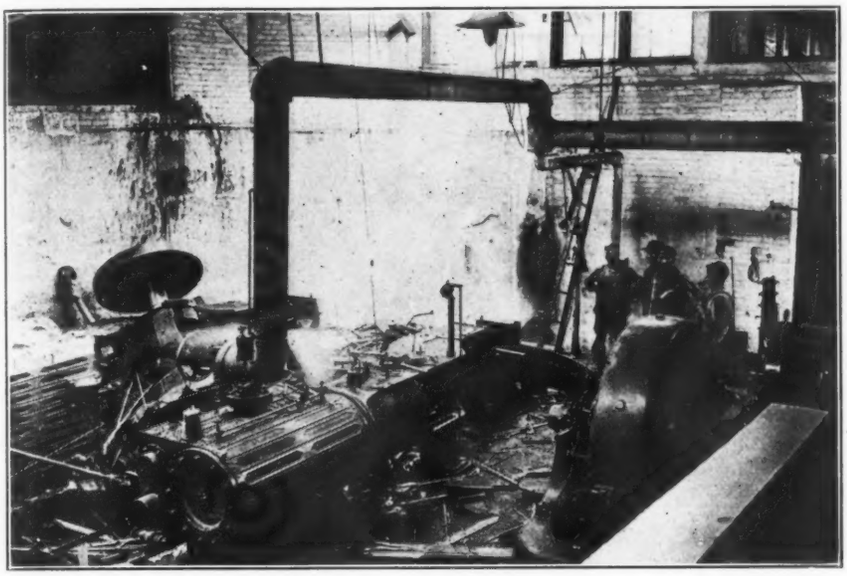


FIG. 1. ONE VIEW OF THE WRECK

The wheel parted into a great many pieces, crashing through the walls and the roof of the plant with terrific force. One piece of the wheel was hurled through the air 500 feet and struck against the walls of the Arnold Print Works, across the river, knocking a hole about 2 feet in diameter through the brick wall. Another piece about 4 feet long dropped in the roadway on the same side of the river as the works and about 200 feet distant. The shafting of the wheel was found completely reversed after the accident, showing that it had been thrown into the air by the force of the explosion and twisted through a half revolution.

Fortunately, no one was killed or injured, although Chief Engineer F. W. Briggs and two other engineers were in the building at the time. The engine was one of the units supplying current for the high-tension lines to Williamstown and Adams, and also for a ventilating fan in the central shaft of the Hoosac tunnel. Due to reserved capacity, the plant was not crippled and is supplying light and power as usual.

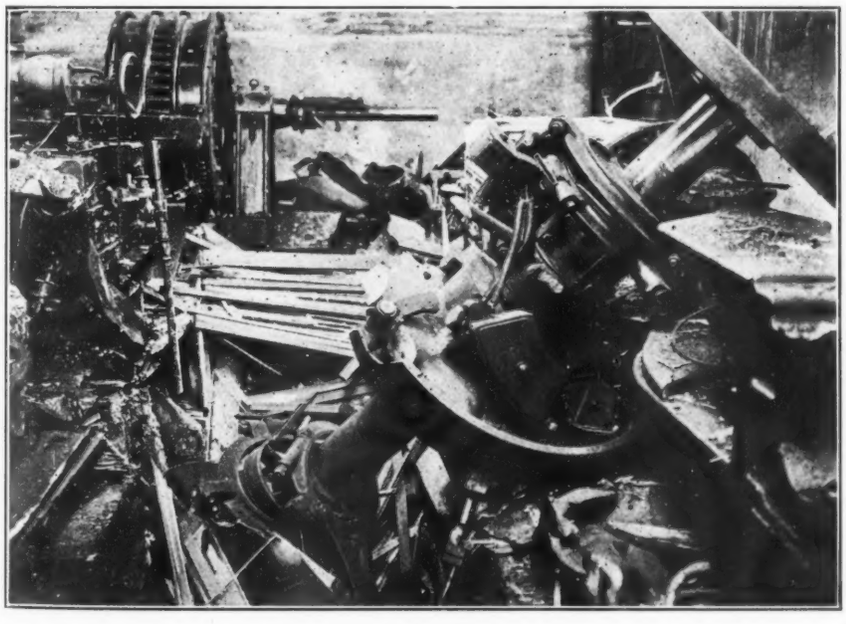


FIG. 2. ENGINE TOTALLY WRECKED

A Simplified Method of Starting Induction Motors

By R. H. Fenkhausen

In three-phase induction-motor operation auto-starters for delta-connected motors may often be dispensed with by the simple expedient of bringing out all six leads from the three phases and using a three-pole double-throw switch to connect the winding in "star" for starting and

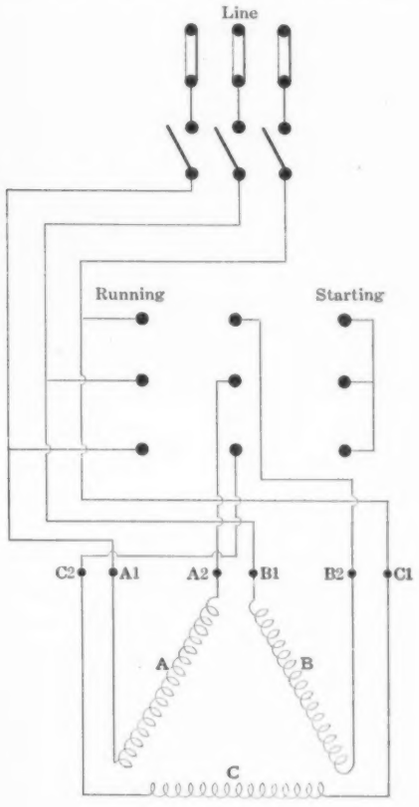


FIG. 1

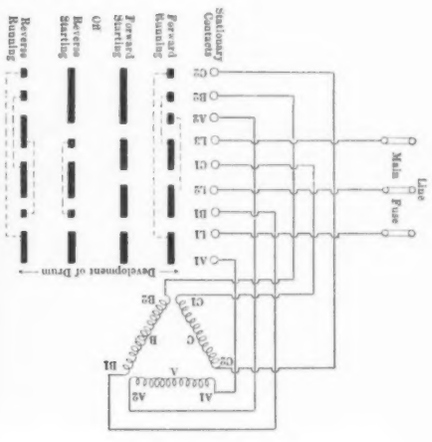


FIG. 2

"delta" for running, being careful not to have any of the phases opposed when reconnecting the motor. The diagram, Fig. 1, on page 289, shows the proper connections. This method gives 57 per cent. of the full voltage at starting, and in most cases this will give sufficient torque.

Fig. 2 is the diagram of connections for a combined reversing controller and line switch for the same purpose, which is similar to one recently placed on the market by a German concern.

Indicator Questions Answered by N. A. S. E. Members

Last November there was mailed to all of the subordinate associations of the National Association of Stationary Engineers a list of indicator questions, and invitations were extended to enter a contest for three prizes: First, an indicator; second, a reducing wheel; third, a planimeter. The intention was to distribute the prizes and announce the winners on April 1, 1908; sickness, however, prevented carrying out the intention until summer was well advanced. Association No. 4, of Indiana, won the first prize; No. 1, of Oregon, the second; and No. 9, of Wisconsin, the third. Distribution of the prizes took place in June.

The questions, together with the correct answers, were as follows:

Question 1—Does the "tail rod" of the indicator piston introduce an error?

Answer—No.

Question 2—Should the drum spring have a uniform tension through the entire range of movement of the drum?

Answer—No. The tension should increase as the cord is drawn out.

Question 3—Does an engine piston leave the crank end at the same rate of speed as from the head end?

Answer—No. The piston travels perceptibly faster from the head end of the cylinder than from the crank end.

Question 4—Mark on the accompanying diagram (Fig. 1) the points of cut-off and release, also the admission line, expansion line, etc.

Answer—The events are marked in the accompanying drawing (Fig. 2), admission, cut-off and release taking place where the direction of the line changes.

Question 5—What is the mean effective pressure of the accompanying diagram (Fig. 3), figured with ten ordinates, and also with twenty?

Answer—With ten ordinates the mean effective pressure is 56.15 pounds; with twenty ordinates, 55.8 pounds. See Fig. 4.

Question 6—What is the mean effective pressure of the accompanying diagram (Fig. 5), taken with a No. 50 spring?

Answer—0.25 pound negative. See Fig. 6.

Question 7—(See Fig. 7).

Answer—The hump and perpendicular

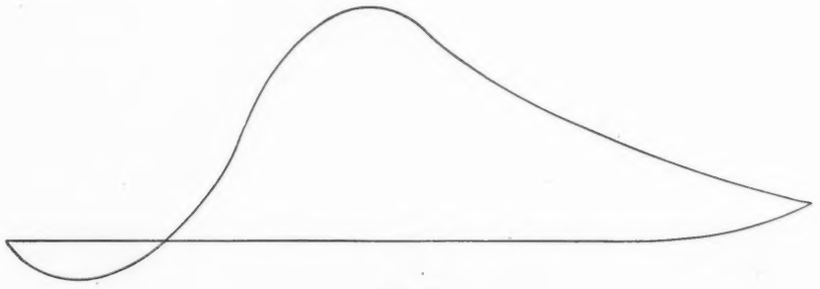


FIG. 1

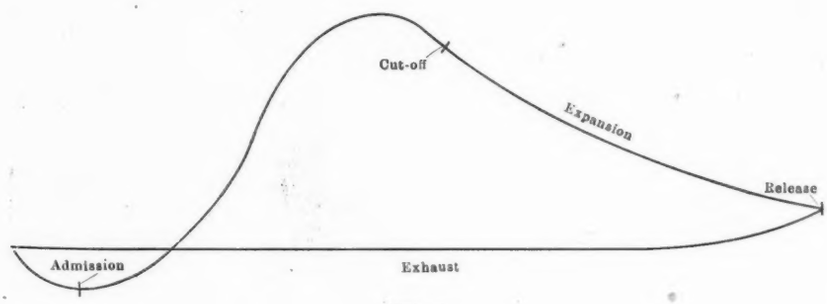


FIG. 2

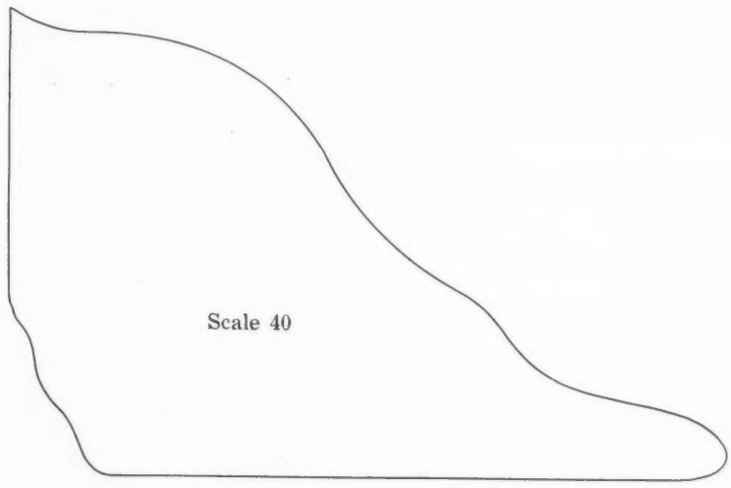


FIG. 3

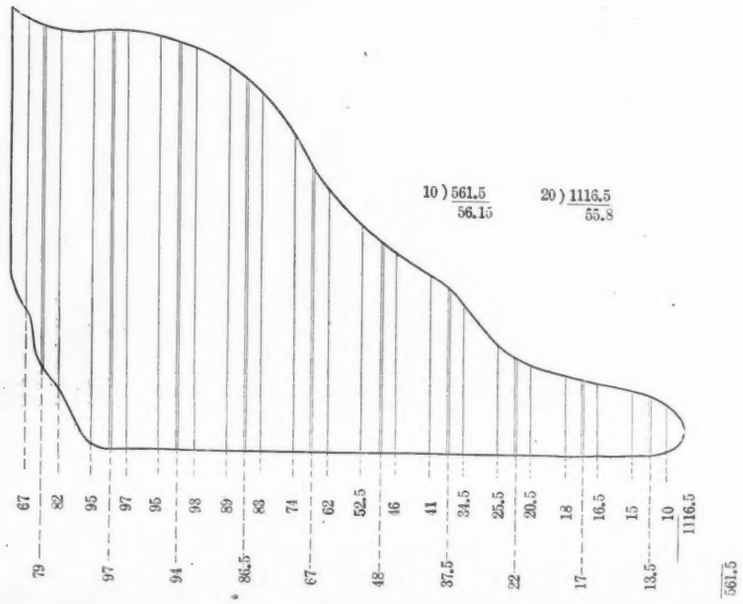


FIG. 4

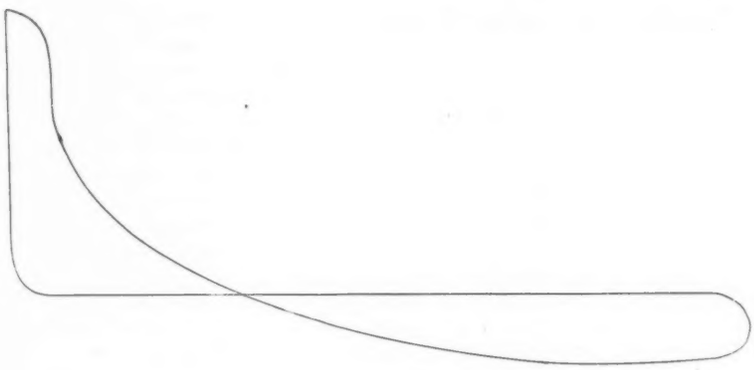
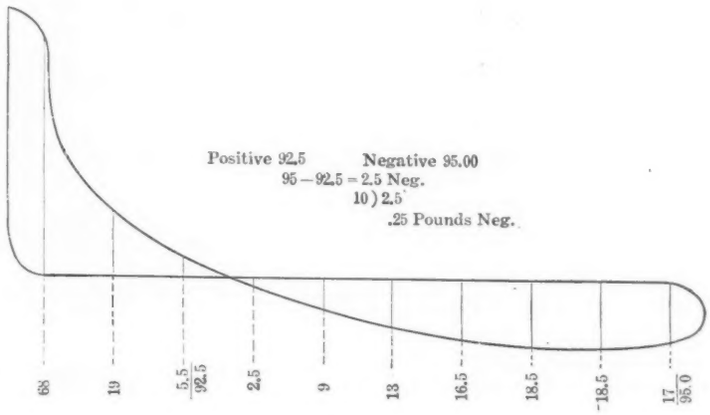


FIG. 5



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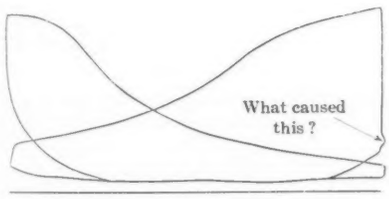


FIG. 7

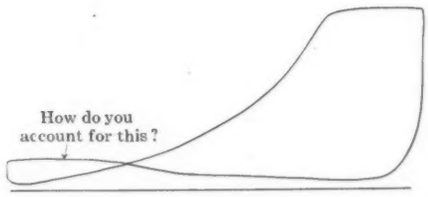
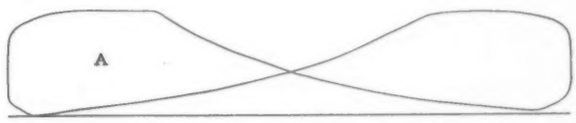


FIG. 8



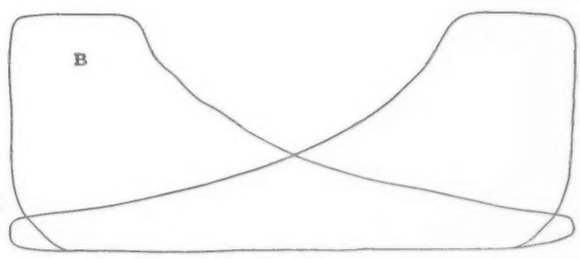


FIG. 9

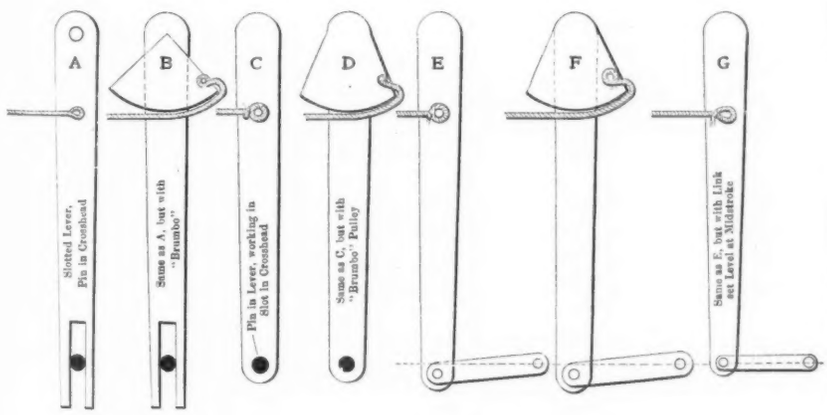


FIG. 10

line were caused by the drum striking hard against the top.

Question 8—(See Fig. 8).

Answer—The indicator cock was screwed into a tee in the center of the indicator pipe, with valves at or near the ends. One valve was wide open, the other partly open.

Question 9—Why the difference between the accompanying cards (*A* and *B*, Fig. 9), which were taken from the same engine, with the same boiler pressure, the same spring and the same indicator?

Answer—In taking card *A*, the indicator was attached the same as in Question 8, both valves being wide open.

Question 10—Which of the accompanying lever motions (see Fig. 10) do you think most nearly accurate, and which most inaccurate?

Answer—*C* is the most nearly accurate; *G* is the most inaccurate.

Ohio Electric Light Association Convention

The fourteenth annual convention of the Ohio Electric Light Association will be held at Hotel Victory, Put-in-Bay, Ohio, on August 25, 26 and 27. An interesting program has been prepared.

Steel Bands in Place of Leather Belting

According to Frank S. Hannah, the United States consul at Magdeburg, it was stated in a recent issue of a German technical paper that the use of steel bands to take the place of leather belting for the transmission of power has been proved practicable, after repeated tests, by a firm in Charlottenburg. The following points of superiority are claimed for this new method: On account of its solidity a much narrower band can be used, one-sixth of the width of the usual leather band being sufficient. As a result of this the steel band is not so heavy as the usual leather band, and, as it can be very tightly adjusted, the distance between the engine and the machine is not a matter of importance, as is the case with the leather belting, where the transmission of power is dependent upon the weight of the hanging belt. Careful and repeated experiments have shown that the entire loss of power is very small, and, as far as can be ascertained, will not exceed 1 per cent. Further, owing to the lightness of weight of the steel belting, it is claimed, the influence of the centrifugal force is not so great and allows of a much increased velocity.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

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Can You Meet the Central Station Man?

Suppose the owner of your plant should say to you tomorrow: "Mr. Engineer, the electric company people say they will furnish me current at four cents a kilowatt-hour. How much more or less is it costing us than that now?"

Your job may depend upon the answer; much of the importance and desirability of your job certainly does. How well prepared are you to give an intelligent and comprehensive reply? Have you a record of coal and supplies, of wages and repairs? Do you know anything about the charges for interest, taxation, insurance and depreciation? Do you know how much, or rather how little, less it would cost to run the plant at a low pressure for heating than it is costing for light, power and heating, too? Can you prepare an intelligent statement of the case, showing that the mere shutting down of the engine or engines is not going to stop the expense chargeable to the plant, by any means, and that what it does not stop must be added to the electric company's estimate? Do you know that upon your ability to do this may depend the decision which will make your situation one for an engineer or one for a janitor?

There is nothing about the keeping of such a record which calls for masterful intelligence or a very large degree of knowledge. Just a little common sense and enough interest to keep a man at it all the year around, and it will pay a return upon the investment.

As the Engineering Field Broadens

Engineering has had many definitions, some qualifying and enlarging rather than actually defining, and all more or less indefinite. This is especially true of steam engineering, which is not an exact science that can be taught by chemistry or arithmetic with the use of textbooks, for in every plant different conditions obtain, and make it practically impossible for the engineer to take a particular paragraph or chapter and apply it to any special case. He must draw from his general store of knowledge, and his alone, for in his work he is practically shut out of daily association with his fellows engaged in the same line. How much the engineer knows about his business decides in what way his problems are solved, or whether they are solved at all, and his method of solving determines to a large extent his position in the field.

In these days rapid strides are being made in all lines, and more and varied applications of power are being brought forward than ever before. Every new development widens the field of the man in the engine room and calls for a broader and more extensive knowledge of his profession. Not many years ago a knowledge of the steam engine and boiler equipment was about all that was necessary. Now the engineer must be familiar with electrical machinery, the gas engine and producer and most of the later developments in auxiliary equipment. Aside from all this he should know the preliminary steps that must be taken in a power-plant installation, something of the design and location of the machinery and the construction of the building, and at the same time he should be deeply interested in a hundred other things.

With such a demand on his resources, it is not surprising that the serious-minded engineer sometimes doubts his own ability and questions his knowledge of the profession; but it is safe to say that if the engineer makes the best of the opportunities that come to him, and occasionally makes an opportunity for himself, he will not be passed unnoticed and his ability will gain the recognition so much desired.

When the Chief was on the Job

He was an old friend of his father and he had seen the boy grow up from a little shaver and succeed to his father's position as chief of a large manufacturing plant.

"Don't you think you ought to come around some morning and see 'Bill' start these things up?" he asked, as they stood watching the steam turbine one afternoon. The turbine was one of the horizontal persuasion and had been running successfully for some three years.

"Start it up! Why, it's nothing but a windmill run by steam. Anybody can start it up. All you've got to do is to open the valve," said the chief contemptuously, and he passed on.

A few months afterward, the assistant who had run the turbine so successfully went away on his vacation. The chief opened the valve and let the steam on, and it blew the "windmill" around at a lively gait; but he had neglected to start his oil pump. The bearings commenced to smoke and fry and he began to sizzle. None of the old standard remedies for hot bearings was of any avail, and the only sensible thing to do under the circumstances he did not do. With a chief's ambition for a record of uninterrupted service, he would not shut down, but let her run until the cylinder split and the machine had to go back to the shop.

There is too much of a disposition to cultivate the impression that the turbine is nothing but a shaft with vanes on it, and that it needs less attention than an overshot water-wheel. There is too much willingness on the part of operating engineers to accept this representation at its face value. If the chief in question had taken the advice of his father's friend and

learned how to care for the machine of which he was in responsible charge, if he had read the recent issues of POWER AND THE ENGINEER and seen what troubles these machines are subject to and what is necessary to avoid them, he would have been able to run his own plant while his assistant was away and would be today a successful chief engineer, instead of being discredited and out of a job.

Analysis of Indicator Diagrams

Careful analysis of indicator diagrams is a recreation that the engineer should indulge in as frequently as possible. Not only those diagrams which are found in the various textbooks which are in almost every engineer's possession, but stray and freak diagrams that sometimes come under his observation should be subject to rigid analysis. Each line should be taken by itself and its influence on the other lines of the diagram and relation to the movement of the piston and the pressure exerted while the line was being drawn studied until its character and meaning are thoroughly understood. Speculation on the manner in which the diagram was made is of no small value, and will often account satisfactorily (to the speculator, at least) for the peculiar-shaped curves that could by no possibility be drawn under right conditions.

Indicator diagrams are supposed to be records of conditions existing in the engine cylinder for the period during which the pencil was held upon the paper; but whether these records are true or false is a matter that should be determined before credit is given to what they tell. Truth in the story told by the diagram is more to be desired than smoothly gliding curves and spider lines; although the operator who insists upon getting fine, sharp lines is usually just as fussy about other things and will see to it that the reducing motion is fairly accurate and in good order. He will also see that the cord is free from stretching tendency, that the attachments to the indicator to the cylinder are as direct and free from elbows and valves as possible, giving the instrument an opportunity to tell the truth as nearly as may be.

Compression lines rise at the closure of the exhaust, following more or less closely the hyperbola, but sometimes a marked variation from this curve is noted. The compression line is drawn while the piston is moving slowly as compared with its average speed, and the drum cord is either drawn out to near the limit or is nearly all in. If the cord stretches perceptibly, the motion of the drum will be retarded as the cord is drawn out and the drum-spring tension increases, and none of the lines drawn at this time will fall exactly where it belongs. Lost motion in the reducing motion itself is also productive of error in the diagram. This would not be the case were the drum-cord tension sufficient to take up all the looseness and keep pressure upon all the pins and moving parts in the same direction all of the time; but as such conditions are not obtainable, the effect of the lost motion is felt at the end of the diagram where the drum remains at rest for an instant after the piston has started on the return stroke. This pause of the drum narrows the vertical space into which the end lines fall, changing the shape of the compression curve and frequently giving evidence of lead of steam valves, condensation and leaking exhaust valves where these conditions do not exist. Too great care in obtaining indicator diagrams cannot be exercised, for with the utmost caution used in guarding against inaccuracies the result will not be a mathematically exact record of the conditions in the cylinder.

The Indicator Competition

It has been stated by correspondents that exception has been taken by some members of the National Association of Stationary Engineers to an editorial which appeared in POWER AND THE ENGINEER of June 16, assuming that engineers, particularly members of the National Association of Stationary Engineers, were being unjustly criticized. The editorial in question was written by a member of the association, who holds that his membership gives him the right to criticize his brothers and attempt to stimulate them, in any fair way, toward excellence. If anybody read in that particular editorial even a hint of injustice or unfairness toward the engineer, he read something that was not in it. The indicator questions to which this editorial referred were, it is understood, sent to all of the subordinate associations in the National association, with the promise that on April 1, 1908, the prizes would be awarded and the winners announced. Unfortunately, a long and serious illness prevented the manufacturer from attending to the matter at the time promised. The answers to the questions were given to a committee who selected the three sets having the highest percentage of accuracy and upon the recommendation of this committee the prizes were awarded, the first prize going to No. 4 of Indiana, with 83 per cent. of accuracy. The second prize was awarded to No. 1 of Oregon, with 76 per cent., and the third to No. 9 of Wisconsin, with 74 per cent.

When it is considered that the National Association of Stationary Engineers is purely an educational institution, and when the questions (published elsewhere in this number) are examined, it will be seen that the percentages are ridiculously low. Some declined to enter the contest because it was considered undignified, some because they regarded it as an advertising scheme in the outcome of which they had little confidence, and others have said that some of the questions could be answered in several different ways correctly.

Nos. 5 and 6 are the only questions in the list in which there could have been any variation in the replies. As a matter of fact, in the replies submitted there was less variation in these answers than in the answers to any of the other questions, there being less than two per cent. difference between the highest and lowest results which inspired the statement that "the engineer is a careful and painstaking worker in classes of work that require manual skill." In the answers to the other questions, in which mental effort, careful analysis, logical reasoning from cause to effect were required, great diversity of replies were received, and it was to these questions that the wrong answers were returned in every case except one, which justifies the statement that "in cases that need the faculty of reasoning from cause to effect, he is neither logical nor proficient."

In computing the mean effective pressure of an indicator diagram by means of ordinates or by the use of the planimeter, no two operators will arrive at exactly the same result, but if the work is carefully done the variation will be so slight as to be negligible. If a diagram is measured with the planimeter on a day when the barometer stands at or near 30 inches, and then laid aside until some day when the mercury registers 29 and again measured, a noticeable difference in area will result; in fact, these differences will probably be greater than the variation in results obtained by different operators on the same day. In view of this fact, the variation in replies to questions 5 and 6 of less than two per cent. between the highest and the lowest is ample proof of the painstaking accuracy which the engineer puts into the work requiring manual skill, and when it is remembered that the engineer's manual work is not conducive to the delicacy of touch required in the use of the planimeter or pricking off uniform spaces upon diagrams for ordinate computation, the uniformity of results is remarkable.

Careful examination of the question list on other pages of this issue will show that there are no catch questions or questions that could be answered correctly in contradictory terms. Nothing that has been written can, by the liveliest imagination, be construed into a "knock" at engineers or their associations. What they as a class lack was pointed out to them in a fraternal spirit by a member of the association, who has always had the best interests of the order in mind in his work and is proud of their achievements.

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

The Heine Superheater

The Heine superheater, recently put into practical operation, is being manufactured by the Heine Safety Boiler Company, of St. Louis, Mo. It consists essentially of a header box, into one side of which are inserted U-tubes, expanded into the tube holes. The outer head of this header box is fitted with hand-holes, to give access to the space between the two heads, which are supported by means of hollow stay bolts, through which a soot blower may be introduced for cleaning the exterior surfaces of the tubes. Fig. 1 shows these points, also the method of installation.

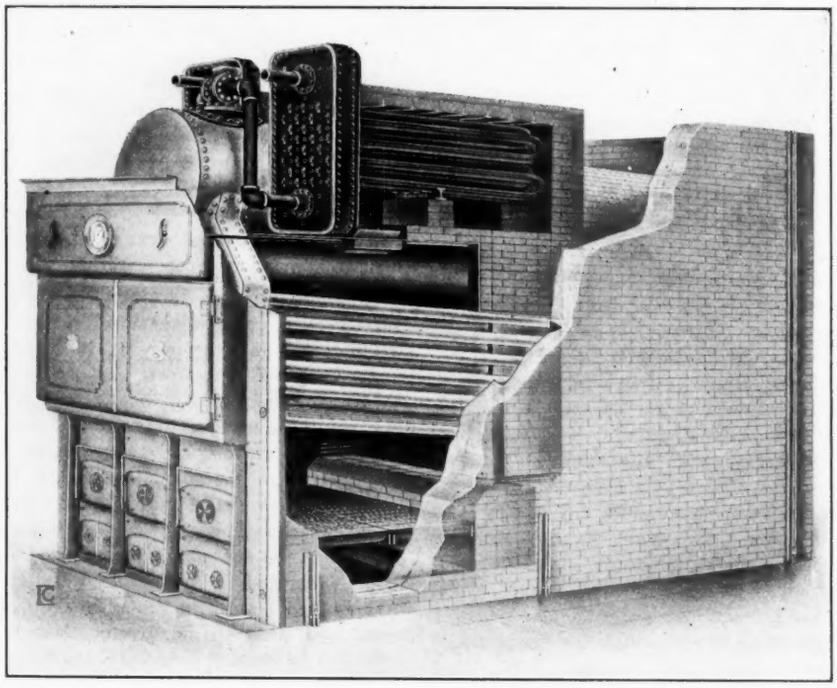


FIG. 1. THE HEINE SUPERHEATER

By referring to Fig. 2 it will be seen that the header box is divided into three compartments by means of light sheet-iron diaphragms, which causes the steam to pass four times through the tubes. The superheater is placed at the side of the shell of the boiler, just above the gas passage from the boiler. The device may be used singly, or in two parts connected together one on each side of the boiler and above the water line.

A small flue built in the side wall of the fittings carries the hot gases direct from the furnace to the superheater chamber, where they make two passages around the superheater tubes, the flow of gases being controlled by a damper. When the damper is closed, as soon as the circulation stops and the heat from the gases in the superheater is absorbed, saturated steam will be delivered. The various degrees of the superheat are obtained by opening the damper as desired.

The usual steam outlet from the boiler proper is connected into the lower opening of the superheater box, the steam passing into the tubes of the lower compartment, where it passes into the second set of tubes connecting with this space, and through them, rising finally into the third or top compartment and out through the top opening into the general piping system.

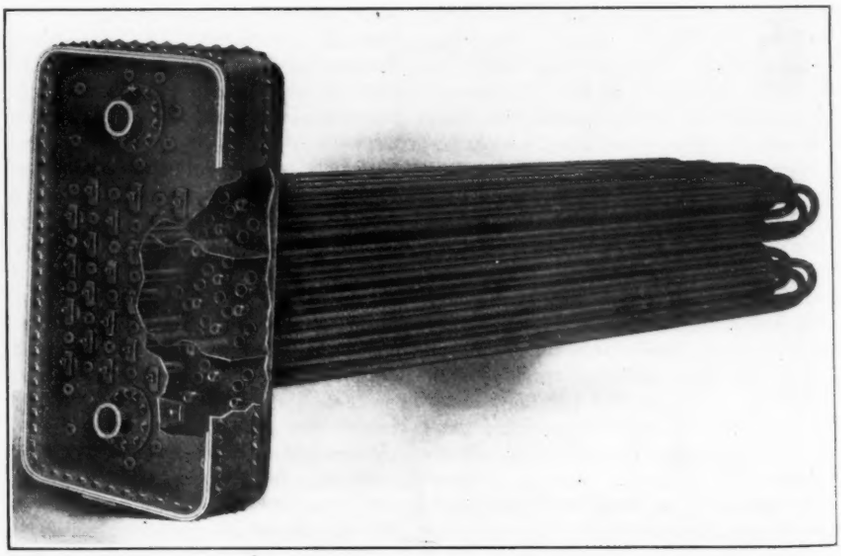


FIG. 2. HEADER CONSTRUCTION, HEINE SUPERHEATER

A New Permanent Magnet, Direct Current Ammeter and Voltmeter

Recent improvements in factory methods and in design features by the Westinghouse Electric and Manufacturing Company have rendered practicable the production of a small-sized switchboard instrument of the permanent-magnet type, at prices comparable with those of the best moving-iron instruments previously available. These instruments are made as ammeters and voltmeters, and are mounted in neat black "electrose" cases, 5 inches in diameter, rear-connected, with circular beveled-glass front plates. Owing to the form and disposition of the per-

manent magnets, an iron case is not necessary for shielding against the effects of external fields.

The voltmeters are self-contained, including their external resistances, in any capacity as high as 300 volts, and the amtal magnetic reluctance of the air-gap too high.

Fig. 2 is an internal view of the meter mechanism with the case removed, and Fig. 3 shows one of the permanent magnets removed from the meter. The latter

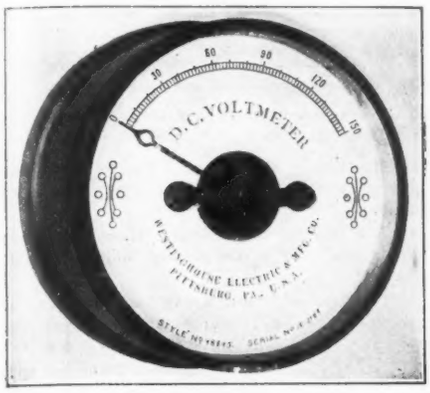


FIG. 1

FIG. 3. SHOWING ONE OF THE MAGNETS REMOVED

meters are operated from external shunts, the shunts of the capacities up to and including 75 amperes being mounted directly on the meter studs. The scale divisions are uniform, and the total length is almost the same as that found in the usual 7-inch meters.

From a technical point of view, the most interesting feature of these instruments is the "single air-gap" construction, which differs considerably from the original D'Arsonval construction with two air-gaps in series. The principal advantages of the single air-gap construction in permanent-magnet meters are, briefly, the possibility of removing the moving ele-

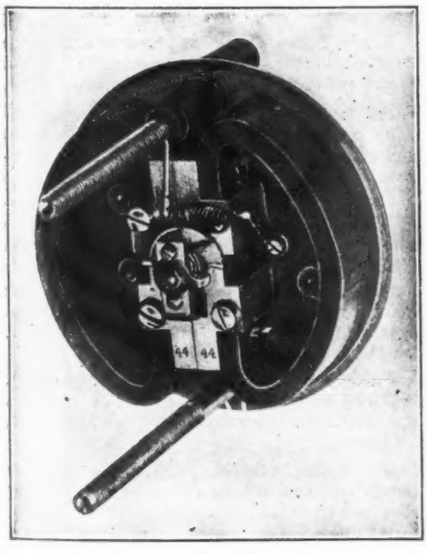


FIG. 2. INTERIOR OF COMPLETE MOVEMENT

ment from the magnetic structure without interfering with the magnets or removing their pole-pieces; the facility with which the coil can be made to balance the weight of the pointer and the ability to use larger air-gap clearances without making the to

view also shows clearly the construction of the pole-pieces and the disposition of the single air-gap. The two magnets form consequent poles at the pole-pieces and the lower pole-piece is cut away to admit one side of the pivoted coil.

The "Michigan" Automatic Drain Valve

A device for saving cylinder oil and preventing the drippings from besmearing the cylinder casing is being manufactured by the Michigan Lubricator Company, Detroit, Mich. It consists merely of a ball float which works freely in a cage, as shown in Fig. 1. The float rises

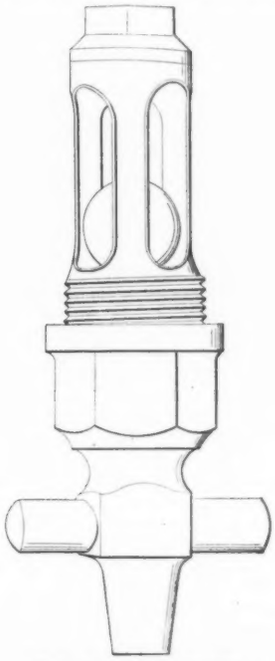


FIG. 1. DRAIN VALVE

and falls with the water level in the lubricator cup, always remaining below the level of the oil but at the surface of the water, when the reservoir contains both oil and water.

When about to fill a lubricator fitted with this drain valve, the water level will be near the top and the ball float at the top of the cage. Upon opening the drain plug, the water level will fall, and when below the top of the cage, the ball float will descend with it to the bottom of the reservoir and, seating, retains the oil in the reservoir, the water having been drained out. After filling the reservoir, the float unseats itself when water accumulates, and rises with the water level to the top of the cage.

When the reservoir is to be cleaned or blown out with steam, the ball float is unseated by screwing the drain plug near-

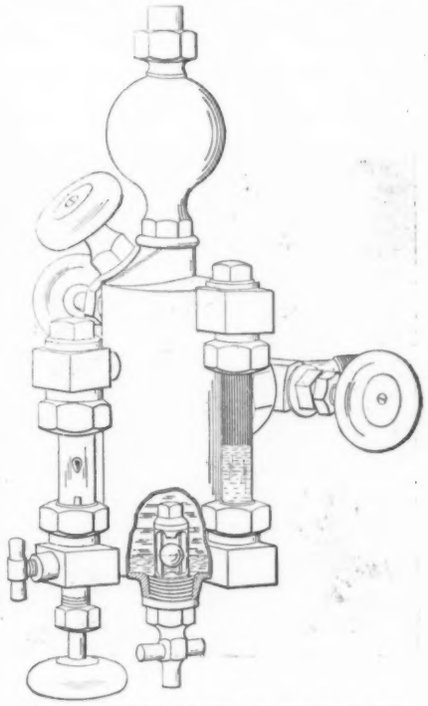


FIG. 2. APPLICATION OF DRAIN VALVE

ly to its seat, when the pin projecting from the top raises the float sufficiently to permit the reservoir to be entirely emptied, after which the plug is screwed into its seat and the lubricator filled. Fig. 2 shows the device attached to a lubricator.

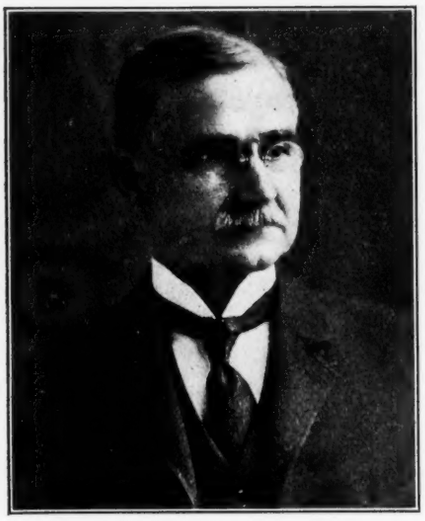
A process for protecting iron and steel from rust has been invented and patented by a resident of Birmingham, England. This consists in immersing the article in a hot phosphorized solution containing an iron compound. The surface of the iron is converted into a mixture of ferrous and ferric phosphates, and presents a pleasing dull-black appearance. This process makes the iron highly resistant to corrosion, and is being applied to all kinds of light engineering work, such as cycle frames, gun barrels, stampings, and press work.

Personal

Prof. William Kent, for five years dean and professor of mechanical engineering in the College of Applied Science, Cornell University, announces the termination of that connection. He expects to devote a year to literary work, especially the revision of his two books, "The Mechanical Engineer's Pocket Book" and "Steam Boiler Economy," but is open for engagement either in educational or engineering lines.

Obituary

Harris Tabor, of the Tabor Manufacturing Company, Philadelphia, inventor of the Tabor steam-engine indicator, the Tabor throttling governor, and other mechanical appliances, died Wednesday, July 29, as the result of a cold following injuries received in an automobile accident on July 4, 1907. Mr. Tabor was born in



THE LATE HARRIS TABOR

Clarence, N. Y., January 26, 1843. In 1882 he became superintendent of the Hartford Steam Engine Company, and in 1883 went to Pittsburg to become superintendent of the Westinghouse Machine Company's works, where he remained nearly two years, after which he opened offices in New York City. He was an active member of the American Society of Mechanical Engineers.

A 400-foot chimney to carry off fumes from the assay furnace is a feature of the new 10-story assay-office building of the United States Treasury Department, which is under construction in New York City. The tall chimney is intended to carry the poisonous fumes entirely above the surrounding high office buildings in the neighborhood, and thus eliminate the nuisance which has been caused by them. —*The Engineer.*

Business Items

On July 28-31, at Ashland, Ohio, occurred the annual convention of the traveling salesmen employed by F. E. Myers & Bro., pump makers. There were felicitous talks by the partners and encouraging reports from the men, resulting in the meeting being of mutual benefit. There were diversions also, such as automobile and trolley rides, base ball, etc

The Farmers' Coöperative Brick and Tile Company, of Mason City, Iowa, has awarded a contract to the Minneapolis Steel and Machinery Company for its complete power plant, including a 20x48-inch heavy-duty Twin City Corliss engine, three 72-inch by 18-foot horizontal return-tubular boilers, a 500-horsepower feed-water heater and a triplex boiler-feed pump.

Forty years ago Adam Cook established the Albany Lubricating Compound and Cup Company in the city of Albany, N. Y., manufacturing "Albany Grease" and specialties in oils and lubricating devices, and now for seventeen years the entire manufacture of these products have been solely made by Adam Cook's Sons, of New York, the firm being composed of the sons of Adam Cook, the originator of "Albany Grease." Adam Cook's Sons now occupy two large buildings located at 313 West street and 520 Washington street, New York City, having increased the output and capacity tremendously since the founder started business in the Albany "hole in the wall," at the time supplying a local trade only. Adam Cook's Sons, who are the only makers of "Albany Grease," attribute the magnitude of their business to the great care that has continually been given the manufacture of their product and in a great measure to persistent advertising, having used a large amount of space and conspicuous position in prominent journals which reach the engineering profession throughout the world. "Albany Grease" can now be had from responsible engine- and mill-supply houses, hardware, oil and auto-supply dealers in every country on the globe.

Among the many improvements that are being made by the Tennessee Coal, Iron & Railroad Company, at the Ensley, Ala., plant, since passing into the hands of the United States Steel Corporation, is the providing for a supply of soft, clear water for boiler feed. A contract has just been entered into with Wm. B. Scaife & Sons Company, of Pittsburg, Penn., to remodel the present water-softening and purifying system and convert it into a "We-Fu-Go" system (intermittent type), with a capacity for 35,000 horse-power of boilers. All apparatus will be discarded except four large tanks in use with the present system, and the new system will consist essentially of eight large treating and settling tanks equipped with patented mechanical stirring devices, and eight large patented mechanical gravity filters. The filters will be installed in a building, in which will be located all the valves, etc., for operating the system. The arrangement of the piping will be such that any or all of the treating tanks can supply water to any or all of the filters. This installation, having a capacity of 3,360,000 gallons of water per 24 hours, will be the largest intermittent-type-water-softening and purifying system in the world. The water taken from Yellow creek in its natural condition contains about 15 grains per gallon of scale-forming solids in solution. By means of the improved softening system it is anticipated that the scale-forming solids in solution will be reduced to a minimum and the formation of scale in pipe lines, heaters and boilers will be entirely prevented. This system will be the thirty-second plant installed for the steel corporation by Wm. B. Scaife & Sons Company; the most recent installation to be completed being a 25,000 horse-power "We-Fu-Go" system for the American Steel and Wire Company's Newburgh works, Cleveland, O.

New Equipment

Dissen & Schneider, Houston, Texas, will establish a cold-storage plant

The Paxton (Ill.) Electric Company is considering the installation of an ice plant.

W. H. Harrington, Dakota, Minn., is having plans prepared for a cold-storage addition.

The Vacuum Ice Company, Baltimore, Md., will erect a new plant to replace the present one.

A new power plant will be installed in the city hospital at Springfield, Ohio, to cost $15,000.

City Council of Basic City, Va., is considering the installation of an electric-light and power plant.

C. W. Southward, Wichita, Kans., is having plans made for a cold-storage building to cost $10,000.

It is reported the St. Louis (Mo.) Independent Packing Company will build a cold-storage warehouse.

The Nevada (Iowa) Electric Company will, it is reported, install an additional engine and generator.

It is reported the Glencoe (Minn.) Electric Light Company contemplates the installation of steam turbines.

The Unaka Tanning Company, Newport, Tenn., will erect an electric plant to furnish power for its plant.

The Cudahy Packing Company, of Omaha, Neb., contemplates establishing a cold-storage plant at Temple, Texas.

The East Point (Ga.) Light and Power Company is planning to erect an electric-light plant and water works system.

The city of Clarendon, Ark., contemplates installing a water and sewer system. About $45,000 will be expended.

The Shelbourne Falls (Mass.) Electric Light and Power Company has bought a site on which it is planned to build a new plant.

The People's Gas and Electric Company, Burlington, Iowa, is contemplating extensive improvements, including another boiler, etc.

A new boiler, engine and generators will be installed in the municipal electric-light plant at Graceville, Minn. H. A. Raitz, superintendent.

The Brunner (Texas) Water and Light Company has secured a franchise to furnish water and light. Will erect and equip electric power-house.

The Retail Merchants' Association, of Belleville, Ill., is considering plans for the construction of an electric-light plant at a cost of about $20,000.

The Rangeley (Maine) Light and Power Company is considering doubling its output. This will involve an expenditure of about $50,000.

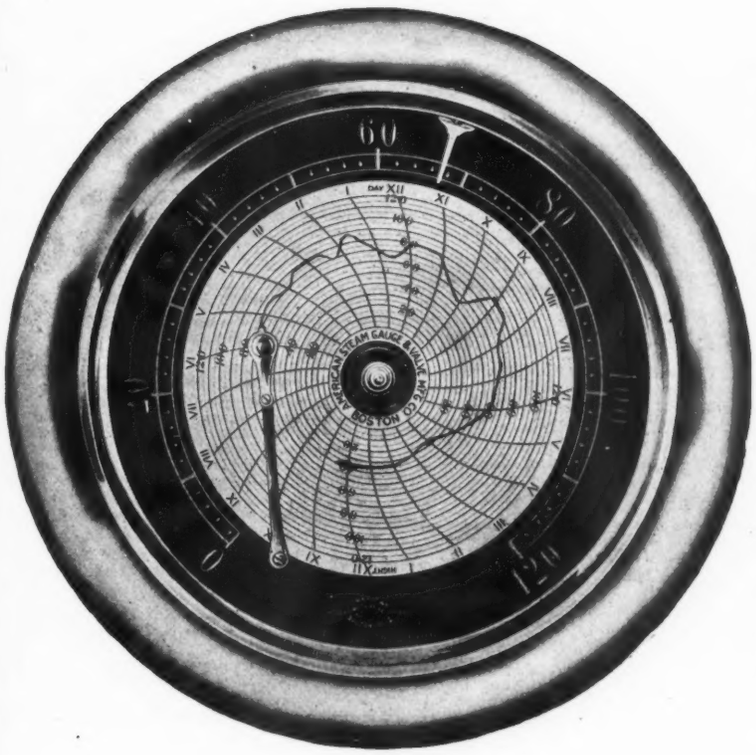
The question of installing a new generator in the municipal electric-light plant at Columbia, Ill., is under consideration. E. L. Rauch, manager.

The Public Service Corporation of New Jersey has awarded contract for the erection of a power house on its property in Marion, Jersey City, N. J.

It is reported that about $30,000 will be expended for remodeling the municipal electric-light plant at Atchison, Kan. Fred Giddings, city engineer.

The Coney Island & Brooklyn Railroad Company is building a new power house at Smith and Ninth streets, Brooklyn, N. Y., and placing its wires underground. About $1,000,000 will be expended. D. W. Sullivan, superintendent.

ECONOMICAL PRESSURE



The MINIMUM PRESSURE at which your machinery can be operated to its fullest capacity is ECONOMICAL PRESSURE. Every pound above, means waste of steam and fuel. Every pound below means reduced efficiency — lazy, slothful machinery and a continual loss of money.

ECONOMICAL PRESSURE can be maintained in your plant through the use of the AMERICAN-COMBINED PRESSURE AND RECORDING GAUGE. It shows the slightest fluctuation. It records the exact pressure carried every minute of the 24 hours and the evidence is in legible and permanent form. It brings economical and safe operation down to actual and positive facts by showing when and where the leaks occur, thus permitting you to correct them.

The AMERICAN COMBINED PRESSURE and RECORDING GAUGE is made for all pressures—water, steam, gas, oil, air, etc., and is guaranteed perfect.

Circular 3-B describes it.

If your jobber does not carry "The American" specialties and will not procure them for you, we will ship to you direct from our factory.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. **Atlanta**, 835 Equitable Bldg. **Chicago**, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex.
Montreal, 444 St. James Street.
San Francisco, 247 Pine Street.
Los Angeles, 213 So. Los Angeles Street.

When ordering gauges, valves, indicators and kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, be sure to specify those manufactured by us. Your interests can be best served by the protection they afford.

New Catalogs

Erie Engine Works, Erie, Penn. Catalog. Engines and boilers. Illustrated, 52 pages, 6x9 inches

Du Bois Iron Works, Du Bois, Penn. Catalog. Gas and gasolene engines. Illustrated, 8 pages, 6x9 inches.

H. G. Osborne, 74 Cortlandt street, New York. Booklet. Osborne extension brick drill. Illustrated, 3½x6 inches.

Emerson Electric Manufacturing Company, St. Louis. Bulletins. Single phase induction motors. Illustrated.

The Bristol Company, Waterbury, Conn. Catalog. Staggered point steel belt lacing. Illustrated, 3½x6 inches.

Olney & Warren, 66 Centre street, New York. Catalog. Gas and gasolene engines. Illustrated, 6 pages, 3½x6½ inches.

Glacier Metal Company, 116 Broad street, New York. Catalog. Anti-friction metal. Illustrated, 20 pages, 6x9 inches.

The Hess-Bright Manufacturing Company, Philadelphia, Penn. Catalog. Ball bearings. Illustrated, 34 pages, 6x9 inches.

American Spiral Pipe Works, Chicago, Ill. Pamphlet No. 22. Taylor spiral riveted pipe. Illustrated, 16 pages, 8x10 inches.

Crocker-Wheeler Company, Ampere, N. J. Bulletin No. 105. Polyphase induction motors. Illustrated, 12 pages, 7½x10 inches.

Simonds Heating and Specialty Company, Detroit, Mich. Booklet. Automatic vacuum valves. Illustrated, 18 pages, 3½x6 inches.

The Jeffrey Manufacturing Company, Columbus, Ohio. Bulletin No. 25. Handling coal and ores. Illustrated, 48 pages, 6x9 inches.

American Steam Gauge and Valve Manufacturing Company, Boston, Mass. Catalog. Gauges. Illustrated, 128 pages, 6x9 inches.

P. H. & F. M. Roots Company, Connersville, Ind. Catalog. Smelting and high pressure blowers. Illustrated, 42 pages, 7½x10 inches.

Northern Engineering Works, Detroit, Mich. Booklet No. 24. Electric traveling cranes, hand power cranes, etc. Illustrated, 32 pages, 3x5½ inches.

Weber Gas Engine Company, Kansas City, Mo. Brochure No. 60. "Down-draft" suction gas producer for bituminous fuels. Illustrated, 4 pages, 4x9 inches.

Asbestos Protected Metal Company, Canton, Mass. Catalog. Asbestos protected metal for siding, roofing and ceiling. Illustrated, 30 pages, 5x7½ inches.

Armstrong Manufacturing Company, Bridgeport, Conn. Catalog. Stocks and dies, water, gas and steam fitters' tools, pipe threading machines. Illustrated, 52 pages, 5x7 inches.

Robt. Wetherill & Company, Chester, Penn. Catalog. Williams vertical compound medium speed engine. Illustrated, 20 pages, 6x9 inches. Catalog. Williams "Monogram" vertical duplex compound engine. Illustrated, 20 pages, 6x9 inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Salesman on commission for high grade power specialties. Address, stating experience, Chas. T. Luce Co., 160 Congress St., Boston, Mass.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEER will pay $50.00 commission to anyone who secures or helps him secure a position as engineer, assistant engineer or station man in Rocky mountains or West. Box 14, POWER.

POSITION as superintendent or manager. Wide and successful experience in marine, mill, pumping engines, hydraulic and steam turbines and Corliss engine manufacture, installation and operation. Box 26, POWER.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

COMMERCIAL ENGINEER, 18 years' experience, steam, gas, electric machinery, would represent manufacturer New York. Manager, sales manager, electrical, mechanical lines. Any location. Box 12, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500 H.P. double Corliss engine, 250 H.P. each side. 23x26, slow speed. This engine is in excellent condition and can be had at a bargain. Address, Fall River Bleachery, Fall River, Mass.

FOR SALE—One Western 150 kw., 3-phase, 1100-volt alternator, with excitor and rheostats; and one 16x20 Russell automatic engine. Good condition, cheap. The Machinery Sales Co., E. L. Wyler, Receiver, Cincinnati, Ohio.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

GAS ENGINES. Two 25-horse-power two-cylinder Nash, hit-and-miss gas engines. Also two 15-kw., 110-volts Westinghouse dynamos. Also Kohler Bros. switchboards, and a gas purifier. All the above used only about two years, and in good condition. Box 29, POWER.

FOR SALE—250 H.P. Green Corliss engine, 20"x48" cylinder. 14'x32" fly-wheel, in good condition. Cheap for cash. W. B. Firmin, 715 Chestnut Street, Philadelphia, Pa.

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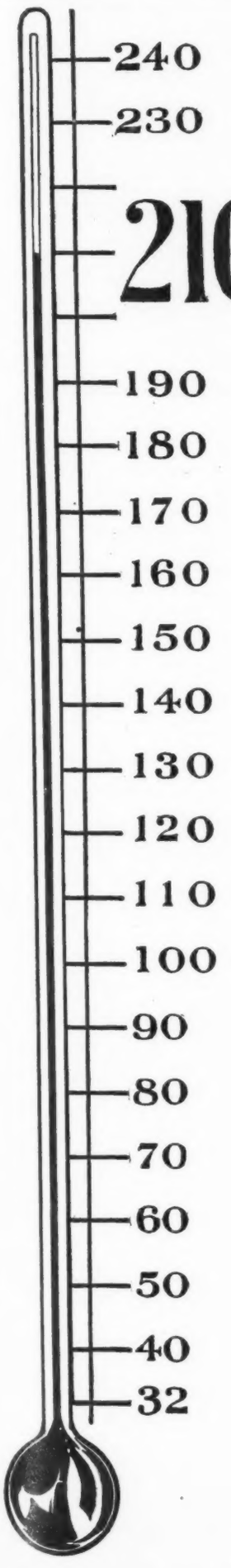
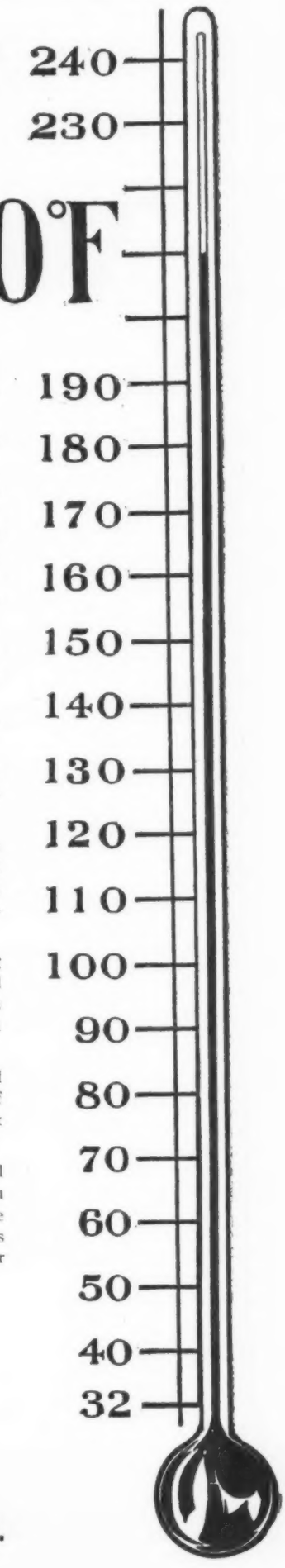


THE TEMPERATURE TO EXPECT



What is the temperature of the feed water entering your boilers? It is important for you to know this, because then you can speculate as to the temperature which you have a right to expect, taking into account the amount of exhaust steam that you have available and the amount of hot water that you require. Just because you have a heater it does not follow that you are getting the full temperature. Lack of temperature means loss of coal.

More than likely if you have a closed heater and have been using it for some time you are not getting more than 150°, 180° or 190°. You ought to have 210°.

Here is what a writer in one of the engineering papers says in a recent article on this subject:

"The association of closed heater manufacturers agreed to rate heaters on a basis of one-third of a square foot of heating surface per horse-power, or one square foot to each three horse-power. The only apparent reason for such action is that it reduces the price of a heater per horse-power, although it does not necessarily make a low priced heater per square foot of heating surface. *They also claim that a final water temperature of 200 degrees is about all that can be expected with this rating.*"

Very true,—and when the heating surface has become fouled with scale on one side and with grease on the other, the temperature will be lower still.

And each 10° F. falling off in feed water temperature means 1% more on the coal bill.

Where the supply of exhaust steam is limited, as it commonly is in modern plants, a closed heater, even if it be as large as all outdoors, cannot give as high a temperature as a COCHRANE HEATER gives.

The reason is that in the Cochrane the heat is transmitted by immediate contact and that the Cochrane conserves all the heat in the condensed exhaust, while the closed heater wastes this heat, about 16% of the total. The Cochrane is, therefore, always able to give 15 or 20° higher temperature than can a closed heater.

Incidentally, the Cochrane Heater saves the condensate also, reducing materially the bill for raw feed water. It further serves as a hot well for all other condensation about the plant that is fit for boiler feed, such as live steam drips and all water condensed from exhaust steam that has been passed through a Cochrane Oil Separator.

Not only does the Cochrane Heater preserve all this pure distilled water, but it also has a purifying action upon the raw water, driving off air and gases and providing for the precipitation and filtration of chalk and magnesia.

If the water you are using for your boilers is hard—it carries the hard scale forming salts such as the sulphates—we most strongly urge you to consider purifying it, for it can be easily done, and at a reasonable cost, with our Hot Process System, which combines all the functions and advantages of our Cochrane Heaters with the means necessary for softening, settling and filtering.

NOT GETTING 210°
OR TROUBLED WITH SCALE

WRITE US.

Ask for Treatise "15-H" on Exhaust Steam.

HARRISON SAFETY BOILER WORKS,

17th and Clearfield Sts., PHILADELPHIA, PA.

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Scully Steel & Iron Co., Chicago, Ill.
Westinghouse Traction Brake Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

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De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.

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Ammonia Fittings

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Johnson Co., Henry, Jersey City, N.J.
Rhoads & Son, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Philadelphia, Pa.

Belt Fasteners

Bristol Company, The, Waterbury, Conn.

Belt Lacing

Bristol Co., The, Waterbury, Conn.

Belting

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa
Robins New Conveyor Co., New York.
Sawyer Belting Co., Cleveland, Ohio.
Shultz Belting Co., St. Louis, Mo.

Belting, Rubber

Bowers Rubber Works, Oakland, Cal.

Benders, Hydraulic

Watson-Stillman Co., New York.

Bends, Wrought Iron Pipe

Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Pittsbusgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Blowers

Beggs & Co., Jas., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
McClave-Brooks Co., Scranton, Pa.
Ohio Blower Co., Cleveland, O.
Scully Steel & Iron Co., Chicago, Ill.
Sirocco Engineering Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass
Wing Mfg. Co., L. J., New York.

Blowers, Furnace

McClave-Brooks Co., Scranton, Pa.

Boiler Door Arches

McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

Boiler Feeders

American Steam Pump Co., Battle Creek, Mich.
Davis Regulator Co., G. M., Chicago, Ill.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Lunkenheimer Co., Cincinnati, O.
Myers & Bro., F. E., Ashland, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Boiler Fittings

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Boiler Skimmers

Buckeye Boiler Skimmer Co., Toledo, Ohio.

Boilers, Second Hand

Wickes Boiler Co., Saginaw, Mich.

Boilers, Tubular

Babcock & Wilcox Co., New York.
Beggs & Co., Jas., New York.
Edge Moor Iron Co., Edge Moor, Del.
Fort Wayne Fdry. & Machine Co., Fort Wayne, Ind.
Franklin Boiler Works Co., Troy, N. Y.
Griffith & Wedge Co., Zanesville, O.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler & Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Oil Well Supply Co., Oswego, N. Y.
Phoenix Iron Works, Meadville, Pa.
Robb-Mumford Boiler Co., Amherst, N. S.
Struthers-Wells Co., Warren, Pa.
Tudor Boiler Co., Cincinnati, O.
Vilter Mfg. Co., Milwaukee, Wis.
Wetherill & Co., Robert, Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Boilers, Water Tube

Babcock & Wilcox Co., New York.
Edge Moor Iron Co., Edge Moor, Del.
Franklin Boiler Works, Troy, N. Y.
Heine Safety Boiler Co., St. Louis, Mo.
Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Oil Well Supply Co., Oswego, N. Y.
Parker Boiler Co., Philadelphia, Pa.
Phoenix Iron Works, Meadville, Pa.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Vogt Machinery Co., Henry, Louisville, Ky.
Wetherill & Co., Robt., Chester, Pa.
Wickes Boiler Co., Saginaw, Mich.

Books, Technical

American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Text Book Co., Scranton, Pa.

Building Materials, Fireproof

Carey Co., The, Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.

Calorimeters

Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Castings, Brass and Iron

Homestead Valve Mfg. Co., Pittsburg, Pa.
McClave-Brooks Co., Scranton, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Castings, General

Neemes Bros., Troy, N. Y.

Castings, Malleable

Jeffrey Mfg. Co., Columbus, O.

Cement, Asbestos

Johns-Manville Co., H. W., New York.
N. Y. Belting & Packing Co., New York.

Cement, Boiler

Smooth-On Mfg. Co., Jersey City, N. J.

Chain Blocks

Yale & Towne Mfg. Co., New York.

Chimneys

Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Reinforced Concrete

Wiederholdt Construction Co., Chicago, Ill.

Chimneys, Steel Concrete

Weber Co., The, Chicago, Ill.

Clamps, Steam Joint

McCrea & Co., James, Chicago, Ill.

Cleaners, Boiler Tube

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Garlock Packing Co., Palmyra, N. Y.
General Specialty Co., Buffalo, N. Y.
Liberty Mfg. Co., Pittsburg, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Pierce Co., Wm. B., Buffalo, N. Y.
Scully Steel & Iron Co., Chicago, Ill.
Stewart Heater Co., Buffalo, N. Y.

Clocks, Engine Room

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Clutches, Friction

Williams Fdry. & Mach. Co., Akron, Ohio.

Coal and Ash Handling Machinery

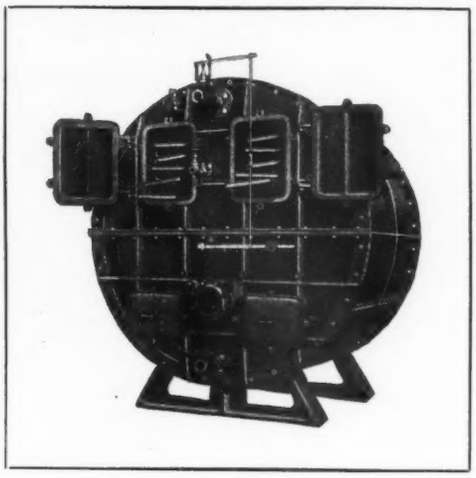
Bartlett & Snow Co., C. O., Cleveland, O.
Jeffrey Mfg. Co., Columbus, O.

Cocks, Blow-Off

Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Cocks, Gage

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., P. B., Philadelphia, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Reliance Gauge Column Co., Cleveland, O.
Williams Valve Co., D. T., Cincinnati, Ohio.



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Cocks, Steam

Homestead Valve Mfg. Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Compound, Boiler

Bird-Archer Co., New York.
Buckeye Boiler Skimmer Co., Toledo, Ohio.
Dearborn Drug & Chemical Co., Chicago, Ill.
Hawk-Eye Compound Co., Chicago, Ill.
Johns-Manville Co., H. W., New York.

Compound, Lubricating

Cook's Sons, Adam, New York.

Condensers

Alberger Condenser Co., New York
American Steam Pump Co., Battle Creek, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric

General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa

Cooling Towers

Alberger Condenser Co., New York.
Baragwanath & Sons, Wm., Chicago, Ill.
Wheeler Condenser and Engineering Co., New York.

Correspondence Schools

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa,

Couplings, Clutch

Williams Fdry. & Mach. Co., Akron, Ohio

Covering, Pipe and Boiler

Carey Co., The Philip, Cincinnati, O.
Johns-Manville Co., H. W., New York.
U. S. Mineral Wool Co., New York.

Crabs

Yale & Towne Mfg. Co., New York.

Cranes

Yale & Towne Mfg. Co., New York.

Die Stocks

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

District Steam Heating

American District Steam Co., Lockport, N. Y.

Draft, Mechanical

Green Fuel Economizer Co., Matteawan, N. Y.
Wing Mfg. Co., L. J., New York.

Drills, Upright

Barnes Co., W. F. & Jno., Rockford, Ill.

Dynamos and Motors, Alternating Current

C & C Electric Co., The, New York.
Clark Bros. Co., Belmont, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
Ft. Wayne Electric Works, Ft. Wayne, Ind.

Dynamos and Motors, Alternating Current—*Cont.*

General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Dynamos and Motors, Direct Current

C & C Electric Co., The, New York.
Crocker-Wheeler Co., Ampere, N. J.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Triumph Electric Co., Cincinnati, O.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Economizers, Fuel

Green Fuel Economizer Co., Matteawan, N. Y.

Educational

American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

Ejectors

Beggs & Co., Jas., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.

Electrical Engineers

Crocker-Wheeler Co., Ampere, N. J.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Northern Electrical Mfg. Co., Madison, Wis.

Electrical Supplies

General Electric Co., Schenectady, N. Y.
Johns-Manville Co., H. W., New York.
Ohio Brass Co., Mansfield, Ohio.

Engineers' Supplies

Mound Tool & Scraper Co., St. Louis, Mo.

Engines, Corliss

Bates Machine Co., Joliet, Ill.
Beggs & Co., Jas., New York.
Cooper Co., C. & G., Mt. Vernon, O.
Griffith & Wedge Co., Zanesville, O.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Providence Eng. Works, Providence, R. I.
Southwark Foundry and Machine Co., Philadelphia, Pa.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co Watertown, N. Y.
Wetherill & Co., Robert, Chester, Pa.
Wheeler Condenser & Engineering Co., New York.

Engines, Gas and Gasolene

Alberger Co., A. H., Buffalo, N. Y.
Buckeye Engine Co., Salem, Ohio.
De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, O.
Fort Wayne Fdry. & Mach. Co., Ft. Wayne, Ind.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Riverside Engine Co., Oil City, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, High Speed

American Diesel Engine Co., New York.
American Engine Co., Bound Brook, N. J.
Ball Engine Co., Erie, Pa.
Bates Machine Co., Joliet, Ill.
Buckeye Engine Co., Salem, Ohio.
Clark Bros. Co., Belmont, N. Y.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Eng. Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.

Engines, High Speed—*Cont.*

Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Phoenix Iron Works, Meadville, Pa.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
Watertown Engine Co., Watertown, N. Y
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Medium and Low Speed

American Diesel Engine Co., New York.
Ball Engine Co., Erie, Pa.
Brown Engine Co., C. H., Fitchburg, Mass.
Buckeye Engine Co., Salem, Ohio.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Erie Mfg. & Supply Co., Erie, Pa.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Ide & Son, A. L., Springfield, Ill.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Reeves Engine Co., Trenton, N. J.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Engines, Oil

American Diesel Engine Co., New York.
De La Vergne Machine Co., New York.

Engines, Rotary

Ball-Cooley Engineering Co., New York.

Exhaust Heads

Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Fans, Electric

Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

Fans, Exhaust and Ventilating

Ohio Blower Co., Cleveland, O.
Sirocco Engineering Co., New York.

Fans, Mine Vetilating

Jeffrey Mfg. Co., Columbus, O.

Feed Water Filters

Beggs & Co., Jas., New York.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Keystone Chemical Co., Philadelphia, Pa.
Northern Water Softener Co., Madison, Wis.

Feed Water Heaters and Purifiers

Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Bates Machine Co., Joliet, Ill.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Erie Mfg. & Supply Co., Erie, Pa.
Goubert Mfg. Co., New York.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Wks., Philadelphia, Pa.
Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., F. L., New York.
Phoenix Iron Works, Meadville, Pa.
Stewart Heater Co., Buffalo, N. Y.

Feed Water Heaters and Purifiers—*Continued.*

Webster & Co., Warren, Camden N. J.
Wheeler Condenser and Engineering Co., New York.
Whitlock Coil Pipe Co., Hartford Conn.
Wickes Boiler Co., Saginaw, Mich

Filters, Oil

Burt Mfg. Co., Akron, O.
Liberty Mfg. Co., Pittsburg, Pa.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Fire Brick

C-O-Two Furnace Co., Syracuse, N. Y.
McLeod & Henry Co., Troy, N. Y.
Presbrey Fire Brick Co., Taunton, Mass.

Fittings, Hydraulic

Watson-Stillman Co., New York.

Fittings, Pipe

Triumph Ice Machine Co., Cincinnati, Ohio.
Ohio Brass Co., Mansfield, O.

Fittings, Steel

Nelson Valve Co., Philadelphia, Pa.

Fittings, Steel Pipe

Nelson Valve Co., Philadelphia, Pa.

Flange Fittings, High or Low Pressure

Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.
Pittsburg Valve & Fittings Co., Barberton, O.
Pittsburgh Valve, Foundry & Construction Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Flanges

Central Station Steam Co., Detroit, Mich.
Scully Steel & Iron Co., Chicago, Ill.

Floats

Anderson Co., V. D., Cleveland, O.
Reliance Gauge Column Co., Cleveland, O.

Forges

Scully Steel & Iron Co., Chicago, Ill.

Furnace Tile

C-O-Two Furnace Co., Syracuse, N. Y.

Furnaces

Continental Iron Works, Brooklyn, N. Y.
Murphy Iron Works, Detroit, Mich.

Furnaces, Smokeless

McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Wilkinson Mfg. Co., Bridgeport, Penn.

Gaskets

American Goetze Gasket & Packing Co., New York.
Brandt, Randolph, New York.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Jenkins Bros., New York.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
N. Y. Belting & Packing Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Smooth-On Mfg. Co., Jersey City, N. J.
U. S. Mineral Wool Co., New York.

Gaskets, Copper

Central Station Steam Co., Detroit, Mich.
Restein Co., Clement, Philadelphia, Pa.
U. S. Mineral Wool Co., New York.

Gage Glasses

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Garlock Packing Co., Palmyra, N. Y.

Gage Testing Outfit

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

"SWARTWOUT"
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are made to last. They are constructed of heavy sheet. All working parts are completely protected from the weather.

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They are MONOLITHIC structures.

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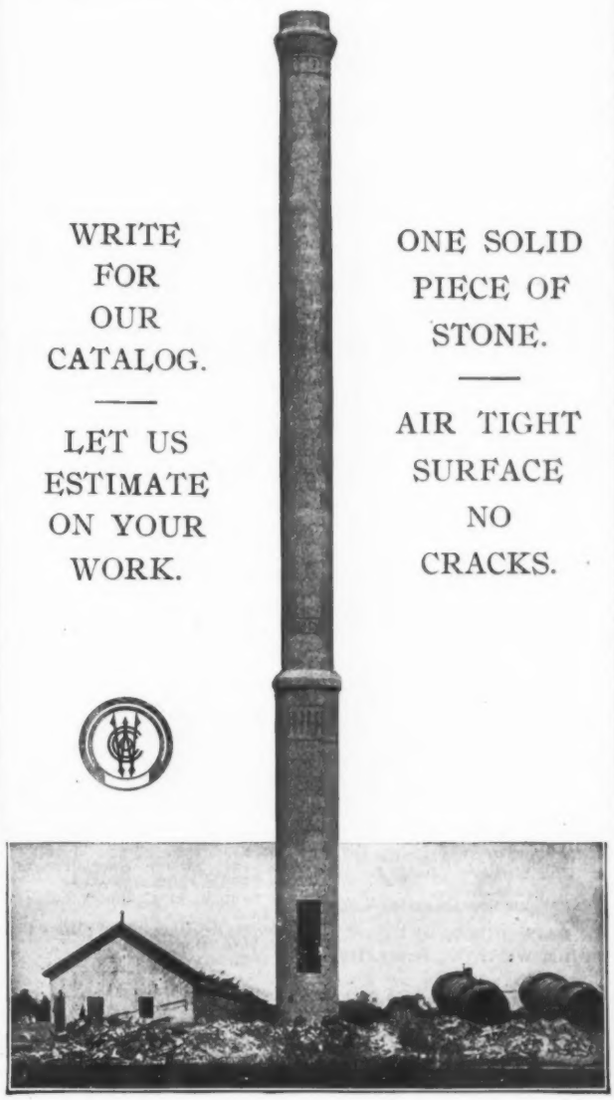

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Gages

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Bristol Co., The, Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.
Huyette Co., Paul B., Philadelphia, Pa.
Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Gages, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Gages, Pressure

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Williams Valve Co., D. T., Cincinnati, O.

Gages, Recording

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gages, Vacuum

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.

Gages, Water

Ohio Brass Co., Mansfield, O.
Safety Equipment Mfg. Co., Chicago, Ill.

Generating Sets

American Engine Co., Bound Brook, N. J.
Crocker-Wheeler Co., Ampere, N. J.
C. & C. Electric Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, Ohio.
Ft. Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Governors, Inertia

Ide & Son, A. L., Springfield, Ill.

Governors, Pump

Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Indianapolis, Ind.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Iowa.
Gardner, Governor & Separator Co., Quincy, Ill.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Garlock Packing Co., Palmyra, N. Y.

Grate Bars

Gibson Iron Works Co., Jersey City, N. J.

Grates

Gibson Iron Works Co., Jersey City, N. J.
Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.

Grates, Clinker Cutting

Neemes Bros., Troy, N. Y.

Grates, Shaking and Dumping

Gibson Iron Works Co., Jersey City, N. J.
McClave-Brooks Co., Scranton, Pa.
Martin Grate Co., Chicago, Ill.
Neemes Bros., Troy, N. Y.

Grates, Stationary

Gibson Iron Works Co. Jersey City, N. J.
Neemes Bros., Troy, N. Y.

Grease

Cook's Sons, Adam, New York.
Keystone Lubricating Co., Philadelphia, Pa.
New York & New Jersey Lubricant Co., New York.

Heating and Ventilating Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

Hoists, Electric

Yale & Towne Mfg. Co., New York.

Hoists, Hand

Yale & Towne Mfg. Co., New York.

Hose

Bowers Rubber Works, Oakland, Cal.

Hose, Air and Oil

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Hose, Steam and Water

Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Indicators, Ammonia

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Indicators, Hydraulic

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Indicators, Speed

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Starrett Co., L. S., Athol, Mass.

Indicators, Steam Engine

American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty and Supply Co., Newark, N. J.
Robertson & Sons, James L., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Trill Indicator Co., Corry, Pa.

Indicators, Valve

Safety Equipment Mfg. Co., Chicago, Ill.

Injectors

American Injector Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Mach. Co., Cincinnati, O.
Schutte & Koerting Co., Philadelphia, Pa.

Insulation

Johns-Manville Co., H. W., New York.

Jacks, Hydraulic

Watson-Stillman Co., New York.

Joints, Expansion

Central Station Steam Co., Detroit, Mich.

Lamps, Arc and Incandescent

Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Locks

Yale & Towne Mfg. Co., New York.

Lubricants

Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
Dixon Crucible Co., Jos., Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
N. Y. & N. J. Lubricant Co., New York.
United States Mica Co., Chicago, Ill.

Lubricators

Cook's Sons, Adam, New York.
Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.
Ohio Lubricator Co., Wadsworth, O.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.

Machinery, Conveying

Bartlett & Snow Co., C. O., Cleveland, O.
Jeffrey Mfg. Co., Columbus, O.

Machinery, Crank Pin Turning

Underwood & Co., H. B., Philadelphia, Pa.

Machinery, Hoisting and Conveying

Allis-Chalmers Co., Milwaukee, Wis.

Machinery, Ice and Refrigerating

De La Vergne Machine Co., New York.
Triumph Ice Machine Co., Cincinnati, Ohio.
Vilter Mfg. Co., Milwaukee, Wis.
York Mfg. Co., York, Pa.

Machinery, Second Hand

Randle Mach. Co., Cincinnati, O.

Machines, Blue Printing

Buckeye Engine Co., Salem, Ohio.

Machines, Portable Milling

Underwood & Co., H. B., Philadelphia, Pa.

Machines, Valve Reseating

Leavitt Mach. Co., Orange, Mass.

Mats and Matting

Mercer Rubber Co., Hamilton Square, N. J.

Mechanical Draft Apparatus

Green Fuel Economizer Co., Matteawan, N. Y.

Mechanical Stokers

Westinghouse Machine Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

Metal, Anti-friction

Allan & Son, A., New York.
St. John, G. C., New York.

Metal Polish

Hoffman, Geo. W., Indianapolis, Ind.

Meters, Water

Blake Mfg. Co., Geo. F., New York.
Deane Steam Pump Co., Holyoke, Mass.

Oil Burners

Hammel Oil Burner Co., Los Angeles, Cal.

Oil and Grease Cups

Cook's Sons, Adam, New York.
Greene, Tweed & Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.

Oil and Grease Cups—*Cont.*

Lunkenheimer Co., The, Cincinnati, O.
New York & New Jersey Lubricant Co., New York.
Philadelphia Lubricator & Mfg. Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, O.

Oilers

Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Oiling Systems

Burt Mfg. Co., Akron, O.
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Oils

Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
N. Y. & N. J. Lubricant Co., New York.

Oils, Non Fluid

N. Y. & N. J. Lubricant Co., New York.

Packing, Asbestos

Diamond Rubber Co., Akron, Ohio.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Restein Co., Clement, Philadelphia, Pa.

Packing, Flange

American Goetze Gasket & Packing Co., New York.
Brandt, Randolph, New York.
Carey Co., The Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Jenkins Bros., New York.
Johns-Manville Co., H. W., New York.
Mercer Rubber Co., Hamilton Square, N. J.
N. Y. Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.
Vanda Co., New York.

Packing, Hydraulic

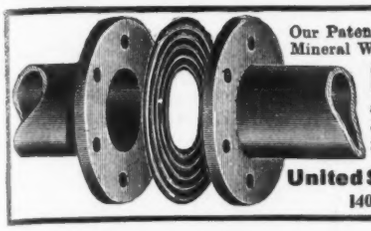
Brandt, Randolph, New York.
Detroit Leather Specialty Co., Detroit, Mich.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Johns-Manville Co., H. W., New York.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Phila., Pa.
Restein Co., Clement, Phila., Pa.
Robertson & Sons, Jas. L., New York.
Steel Mill Packing Co., Detroit, Mich.
Vanda Co., New York.

Packing, Metallic

American Goetze Gasket & Packing Co., New York.
Bowers Rubber Wks., Oakland, Cal.
Canfield Mfg. Co., Philadelphia, Pa.
France Packing Co., Philadelphia, Pa.
Houchin-Aiken Co., Brooklyn, N. Y.
Johns-Manville Co., H. W., New York.
Mercer Rubber Co., Hamilton Square, N. J.
Monarch Steam Blower Co., Troy, N. Y.
Power Specialty Co., New York.
Restein Co., Clement, Phila., Pa.

Packing, Piston Rod

American Goetze Gasket & Packing Co., New York.
Bowers Rubber Works, Oakland, Cal.
Canfield Mfg. Co., Philadelphia, Pa.
Carey Co., The Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Eureka Packing Co., New York.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Johns-Manville Co., H. W., New York.
New York Belting and Packing Co., New York.
Peerless Rubber Mfg. Co., New York.



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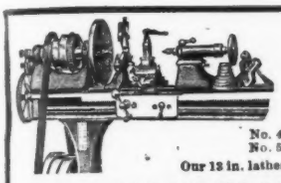

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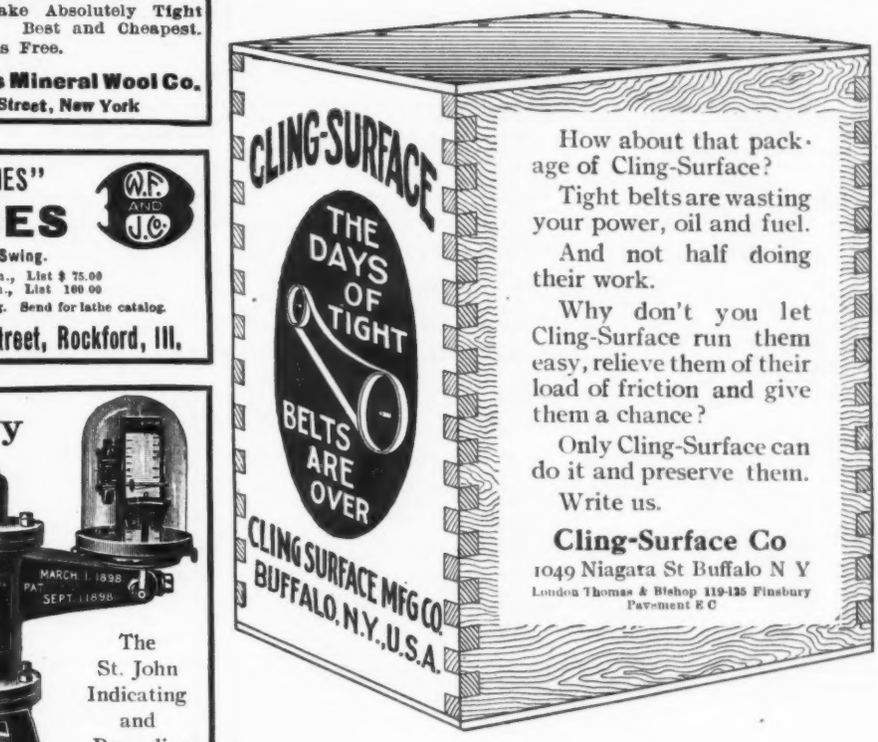

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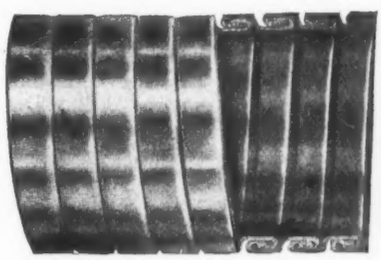

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Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.

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Saginaw Mfg. Co., Saginaw, Mich.

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Williams Fdry. & Mach. Co., Akron, Ohio.

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Deane Steam Pump Co., Holyoke, Mass.
Wheeler Condenser & Engineering Co., New York.

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Kewanee Boiler Co., Kewanee, Ill.

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d'Este Co., Julian, Boston, Mass.
Fisher Governor Co., Marshalltown, Ia.
Harrison Safety Boiler Works, Philadelphia, Pa.
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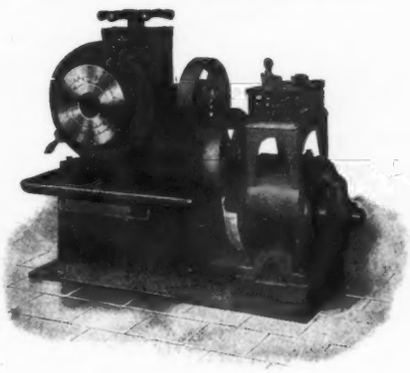

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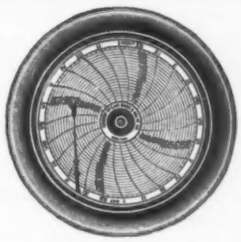

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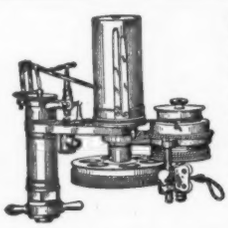

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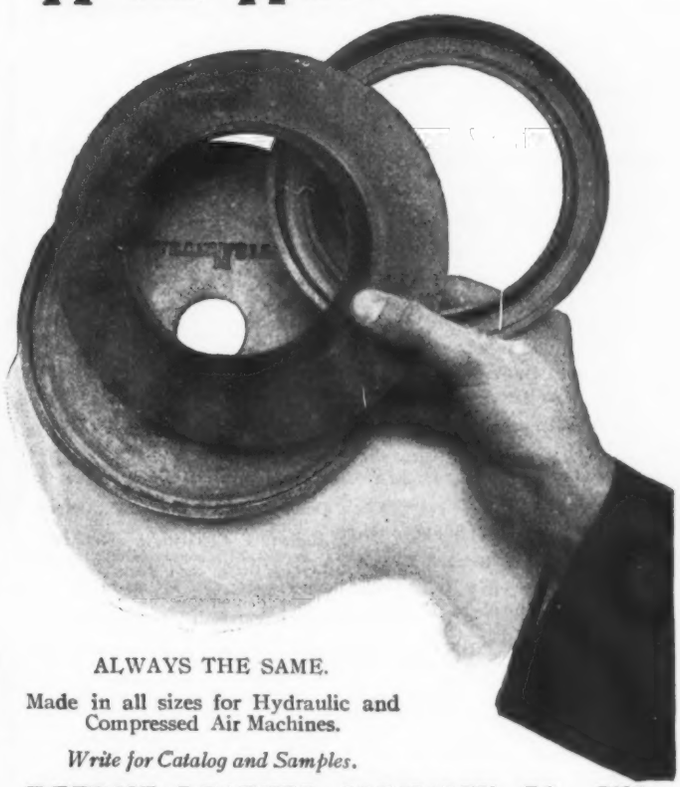

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Westinghouse Mach. Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

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Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

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Yale & Towne Mfg. Co., New York.

Transformers and Converters

General Elec. Co., Schenectady, N.Y.
Westinghouse Electric and Mfg. Co., Pittsburg, Pa.

Traps

Anderson Co., V. D., Cleveland, O.
Central Station Steam Co., Detroit, Mich.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.

Traps—*Continued.*

Jenkins Bros., New York.
Kitts Mfg. Co., Oswego, N. Y.
McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Nason Mfg. Co., New York.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Schutte & Koerting Co., Phila., Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Phila., Pa.
Williams Valve Co., D. T., Cincinnati, O.

Tube Cleaners

General Specialty Co., Buffalo, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
McCrea & Co., James, Chicago, Ill.
Pierce Co., Wm. B., Buffalo, N. Y.
Robertson & Sons, Jas. L., New York.
Sherwood Mfg. Co., Buffalo, N. Y.

Tube Cleaner Rods

McCrea & Co., James, Chicago, Ill.

Tube Cutters

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Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
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General Electric Co., Schenectady, N. Y.
Scully Steel & Iron Co., Chicago, Ill.
Westinghouse Machine Co., Pittsburg, Pa.

Unions

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Pittsburg Valve and Fittings Co., Barberton, O.
Williams Valve Co., D. T., Cincinnati, O.

Valves

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Ashton Valve Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Jenkins Bros., New York.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
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Pittsburg Valve & Fittings Co., Barberton, O.
Pittsburg Valve, Foundry & Construction Co., Pittsburg, Pa.
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Walch & Wyeth, Chicago, Ill.
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Lagonda Manufacturing Co., Springfield, O.
Walch & Wyeth, Chicago, Ill.

Valves, Automatic Relief

Walch & Wyeth, Chicago, Ill.

Valves, Back Pressure

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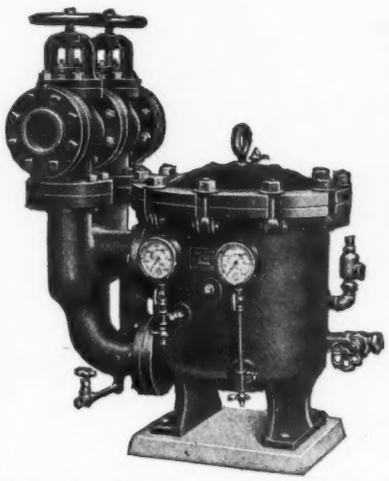

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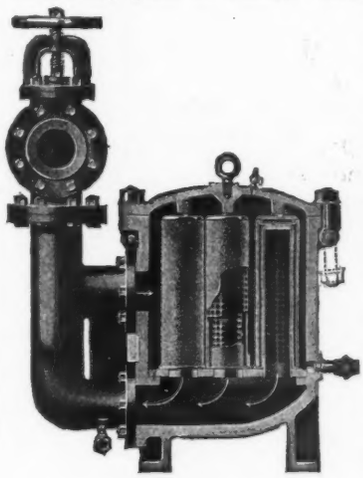

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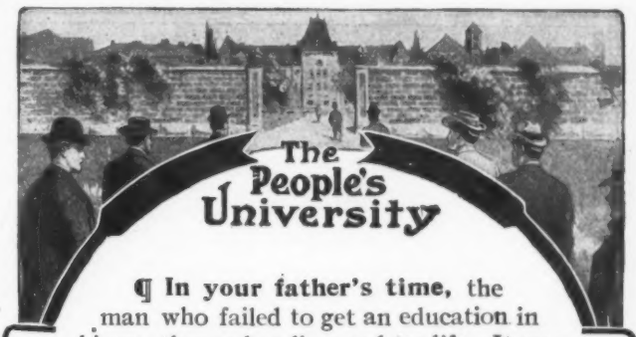

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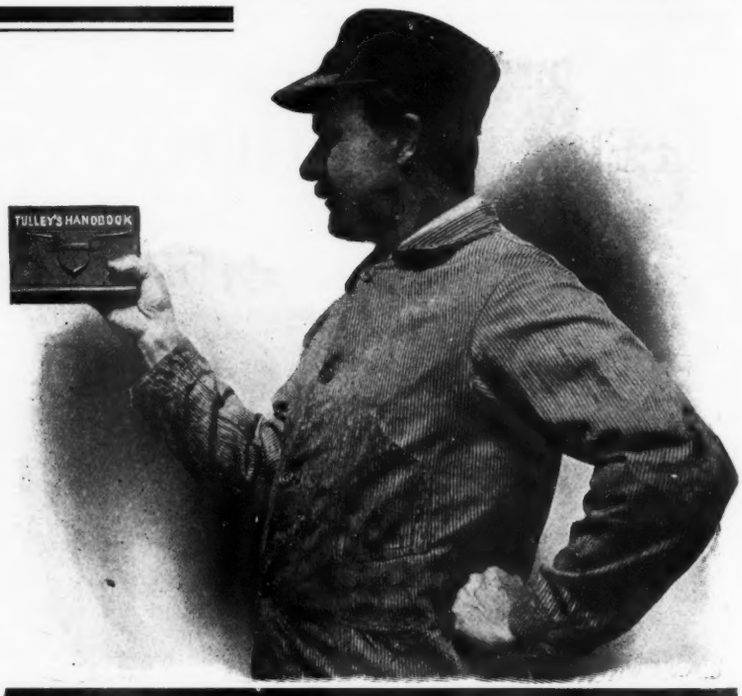

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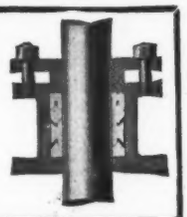

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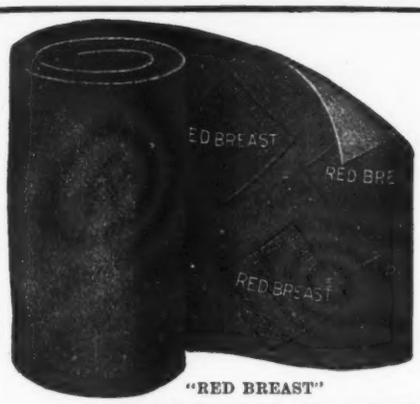

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Red Breast Packing

A Standard Red Sheet Packing—Will not crack or harden under any degree of heat; absolutely impervious to the influence of alkalies, oils and ammonia; positively won't contract or expand; and will withstand the highest pressure.

Write for Free Sample

This packing is better than others—far better—and, better still, is lower priced. We will gladly send samples **Free** upon request.

MERCER RUBBER CO., Hamilton Square, New Jersey

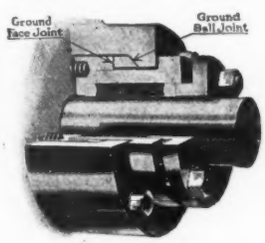
BRANCH OFFICES—Philadelphia, New York, Pittsburg, Denver, 610 Exchange Bldg., and Chicago, 40 Dearborn St.

VIBRATING STUFFING BOX

"SAFETY"

PLASTIC

Metallic Packing



"It Floats with the Rod"

FOR STEAM, WATER, AIR, GAS, HYDRAULIC MACHINES, VALVES, ETC.

Guaranteed to stand Steam Temperature up to 550 degrees F. and Hydraulic Pressure to 5,000 lbs. per square inch.

HIGHEST AWARD WORLD'S FAIR, ST. LOUIS.

Send for Free Sample and Particulars

Manufactured Solely by STEEL MILL PACKING COMPANY, Detroit, Mich., U. S. A.

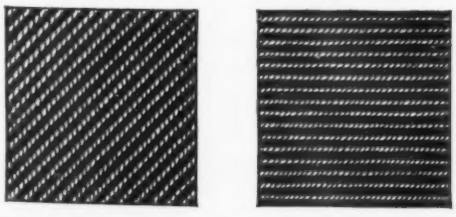
"DODS" DIAGONAL PISTON ROD PACKING

The Perfect Cross-Expansion Packing.

In one piece, it has all the claimed merits of packing composed of wedge-shaped pieces, as it has an expansive power three times greater than any other packing. The unusual expansion of "DODS" PACKING (100 per cent.) enables it to be used with absolute safety on the piston rods of engines or pumps, air compressor or hydraulic work.

CROSS SECTIONS OF

"DODS" PACKING ORDINARY PACKING



Pat. March 15,'98

IT PRODUCES LESS FRICTION,

wears longer than any other packing, and holds steam, air or liquids perfectly tight, as with slight adjustment of the gland nut it will expand and fill every space. Full description and samples for practical test will be sent free.

Address Department "E,"

BOWERS RUBBER WORKS, 57 Sacramento St., San Francisco, Cal.

In Summer's heat, this maiden neat
goes to the shore for rest
But even here, she sees quite clear
riding the ocean crest
The same glad sight, that makes things right
No matter what the test
It goes to show, what a I should know,
BLACK SQUADRON is the best.

BLACK SQUADRON

is the one packing that never fails. Others may do fairly well for some kinds of service, but why take chances—*be sure* and *make sure*, by using the original sliding wedge Black Squadron Packing. High and Low pressure varieties for Steam, Water, Air, and Ammonia. Illustrated Catalog on request.

CANCOS MFG. CO.,
Philadelphia, Pa.

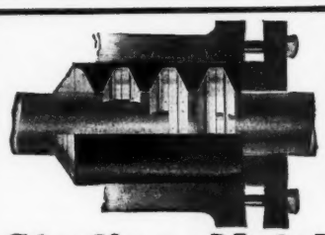
10 Oliver St., Boston, Mass. 525 Third Ave., Pittsburg, Pa.
805 Plowman St., Baltimore, Md.

We Are Ready To Prove

ZENA

that Selden and Zena Packings are better made and made of better materials than any packings. Write.

Randolph Brandt,
72 Cortlandt Street, New York.



For Piston Rods For Upright Engines

Sterling Metallic Packing

It keeps the rods smooth and requires but little lubrication. Imparts a steadying to the rods and stems without creating friction. Allows for rod vibration and untrue alignment.
Users say that our packing saves trouble and MONEY. We guarantee to fit any type of steam engine or pump without altering the stuffing boxes. Its peculiar construction permits easy replacing at any time.
Sold on trial for steam, air, oil and ammonia rods. Catalog?

Monarch Steam Blower Co.,
Troy, N. Y.

VANDA

A STEAM PACKING THAT IS A STEAM PACKING

TRADE MARK. REG. IN U. S. PAT. OFF.

All Goods Stamped with the VANDA TRADE-MARK will fulfill the claims we make for them.

VANDA SHEET PACKING

THIS PACKING IS THE PIONEER OF ALL COMPOSITION PACKINGS, AND IMITATORS ARE APPEARING IN GREAT NUMBERS. WE THEREFORE, WOULD ESPECIALLY CALL YOUR ATTENTION TO OUR

TRADE-MARK DEVICE STAMPED ON EVERY SHEET

GOODS MADE IN SHEETS ONLY OF 4½' x 4½' AND 4½' x 9', IN ALL THICKNESSES

THE VANDA COMPANY, 96 SPRING STREET, N. Y.

H. W. JOHNS-MANVILLE CO., CO-DISTRIBUTORS

BELMONT
"1903"
EXPANSION PACKING

For Steam and Ammonia

Pat. Feb. 24, 1903.

See the sliding wedge?

When you place a ring in the stuffing box pull the ends of one wedge ahead of the casing ends, and push the other one back, then when the ring is closed and ready for service the joint is divided into three breaks, occurring at different points on the circumference. This feature enables one ring of **Belmont 1903 Expansion Packing** to stop steam as effectively as three rings of ordinary packing, and makes it especially valuable for shallow stuffing boxes. Material throughout is the best obtainable, and **Belmont 1903 Expansion Packing** (fully described in booklet A) is guaranteed for any service with steam or ammonia up to 125 lbs. pressure. Above this pressure our "high pressure" packing (write for booklet B) is to be preferred. *General Catalog on Request.*

FREE!

Send for a sample ring and be convinced.

CLEMENT RESTEIN CO.,
Philadelphia, Pa.

Gentlemen:—
Send me a sample ring of Belmont 1903 Expansion Packing

Name.....

Address.....

Firm Name.....

Number of Engines.....

Number of Pumps.....

Number of Boilers.....

High or Low Pressure.....

Packing now in use.....

Power, 7-1-8-08.

CLEMENT RESTEIN COMPANY

133 North Second St. PHILADELPHIA, PA.

Ever See Any Metallic Packing Like This Before? It's

Ambest
TRADE MARK

The new packing composed of long pliable filaments of non-friction metal treated with our mineral lubricating compound.

The parts next the moving rod or stem quickly acquire a glazed surface, wonderfully smooth and slippery, while the outer parts retain their original fibrous condition.

It withstands the highest temperature of super-heated steam; and is unaffected by acid, water or ammonia.

It can't be blown out or sucked in, no matter what the speed or pressure: and, since its volume never changes, a rod once packed stays packed.

It contains no animal or vegetable material whatever, consequently cannot carbonize and cut the rod.

—FREE—

If you want a sample fill in and send to us the coupon below:

Canfield Manufacturing Co., Phila., Pa.

Gentlemen:— Kindly send me free, a sample of Ambest Metallic Packing.

Name.....

Name of Firm.....

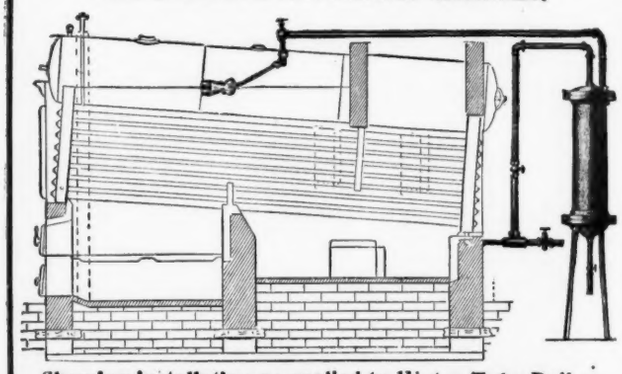
Address.....

Number and Total H. P. of Engines.....

Canfield Manufacturing Co., Ltd.

Philadelphia, Pa.

THE BUCKEYE AUTOMATIC SKIMMER



Showing installation as applied to Water-Tube Boilers

Not One Cent for Boiler Compounds or Mechanical Cleaners

They are no longer necessary where the Buckeye is at work. Other results of its operation are decreased coal bills, minimum repair costs, and top notch efficiency. *Write.*

BUCKEYE BOILER SKIMMER CO.,
SOUTH END, TOLEDO, OHIO.

FIVE POUNDS OF SCALE PER HOUR

may easily collect in a 250 H. B. Boiler, or if running condensing, enough oil and grease from the condensation, though less in quantity, may become even a greater menace.

BIRD-ARCHER BOILER COMPOUNDS

will not only prevent this matter from adhering to the heating surfaces, but actually pay big dividends by cutting scale prevention to the lowest possible cost, by keeping boiler capacity high and heating surfaces clean and by doing away with the delays and repair expenses which always result from scale formation.

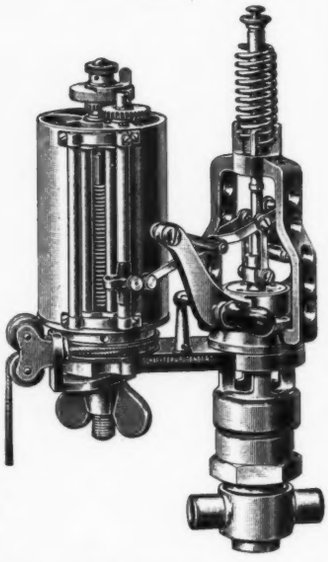
Sold on a "NO CURE, NO PAY" basis.

WRITE FOR CATALOG.

THE BIRD-ARCHER CO. 90 WEST ST. NEW YORK

8

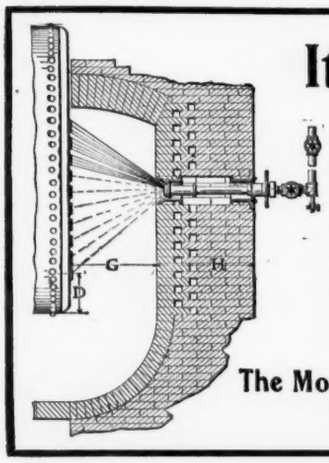
The Thompson
Improved Continuous Card Indicator



The Most Modern, Useful and Practical Indicator on the Market.

This indicator shows not only the condition at a specific moment, but for a time sufficiently long to determine the true condition by the average showing. For engines in traction power stations and rolling mills, or wherever the load constantly varies, the continuous card diagram is of utmost value, and you will appreciate it when you know that from 50 to 100 indications can be taken without removal of the paper. Write for new catalog.

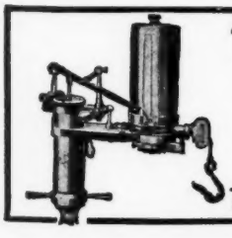
The Schaeffer & Budenburg Mfg. Co.,
Foxboro, Mass.
23 Dey St., New York. 15 W. Lake St., Chicago.



It's Nonsense

to talk about fuel economy if you don't keep your boilers clean. Soot is the most expensive thing about the boiler room. The Monarch Steam Flue Blower will remove it for you without loss of time or steam pressure. Blows with the draft from the rear of the boiler and Saves Fuel. Circular?

The Monarch Steam Blower Co.
Troy, New York



Try A Trill It Will Cost You Nothing

And if you are satisfied and want to keep it after the trial it will cost you $50 less than any other.

It's just a better instrument at a lower price.

Trill Indicator Co., Eagle St., Corry, Pa.

ELEPHANT BRAND

DELTA
REG. U. S. PAT. OFF.

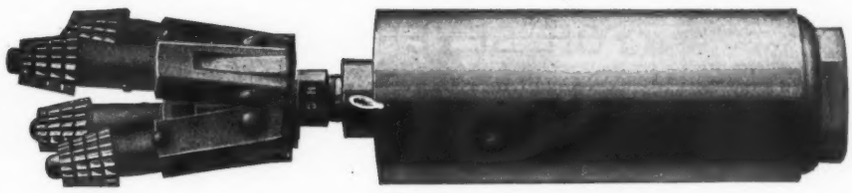
THE PHOSPHOR BRONZE SMELTING CO., Limited.
2200 WASHINGTON AVENUE, PHILADELPHIA, PA.
ELEPHANT BRAND "Phosphor Bronze"
INGOTS, CASTINGS, WIRE, RODS, SHEETS, Etc.
— DELTA METAL —
CASTINGS, STAMPINGS AND FORGINGS
ORIGINAL AND SOLE MAKERS IN THE U. S.

Ever Know a Pump or Pipe Line to Clog up While the Strainer was Being Cleaned?

It may happen any minute unless you stop pumping while the strainer is being cleaned and that would mean too great a loss.

On the other hand a pipe may clog up in two minutes and require two days to get clear.

Ask about the Twin Strainer, one side cleans while the other side strains.

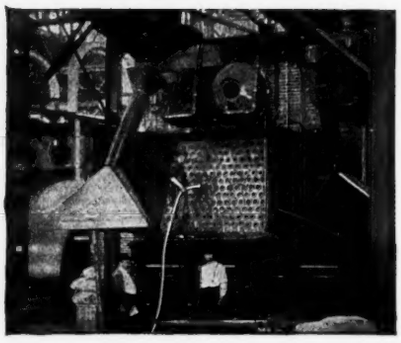


We also manufacture The Liberty Turbine Cleaners and Oil Purifiers the one prevents enormous waste of coal while the other saves many times its cost in oil and both operate a lower cost than any other devices ever constructed for their respective purposes. *Write.*

Liberty Manufacturing Company

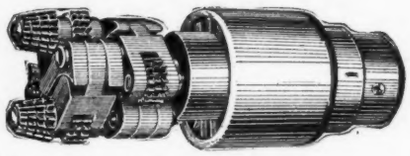
6509 Susquehanna Street - - Pittsburg, Pa.

WEINLAND TURBINE AND MECHANICAL CLEANERS



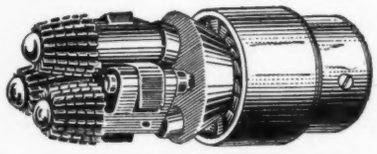
Weinland Turbine Cleaner removing scale from the boilers of the St. Louis Exposition.

FOR STRAIGHT TUBES

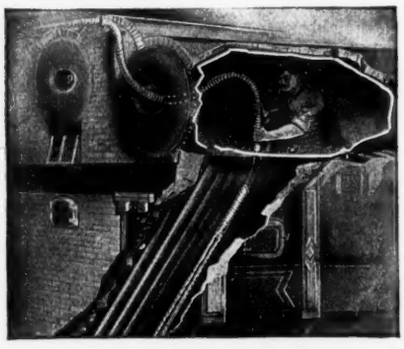


This **Weinland Wing Head** is the best Head ever made for Turbine Cleaners. The heavy wing arms fly out and reduce the scale in no time. It is stronger, more durable, and costs less to keep in repair than any head ever made by any one. It is furnished with all new, and can be used on all **Weinland Cleaners** now in use. Cleaners furnished with ball bearings for light, and thrust bearings for heavy scale.

FOR CURVED TUBES



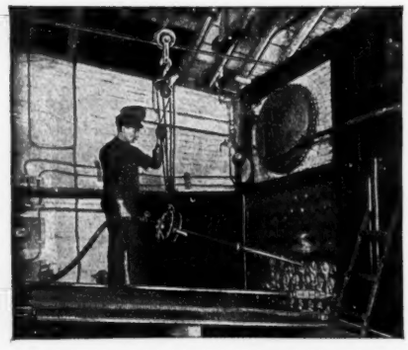
This cut shows Cleaner with **Wing Head** suitable for **curved tubes.** It possesses every merit of the straight tube cleaner, but the cutter heads and barrel are shortened to traverse the bends easily. Our hose coupling is perfectly smooth on the outside so it can't impede the progress of the cleaner. If you have Stirling or similar boilers you should have this cleaner. Cleaners made with either thrust or ball bearings.



Weinland Turbine Cleaner at work in a Stirling Boiler.

FOR SEVERE SCALE

an inch thick or Tubes "chuck full." This **Mechanical Cleaner Head** is the only one that will do the work speedily and economically. In tubes "chuck full" of scale it is the ONLY CLEANER that CAN do it. Can be driven by steam, electric, water or air motor, any desired power. We'll sell or rent this Cleaner or clean your boiler by contract. You can learn A LOT during the operation and afterward, by using our Turbine with reasonable frequency, can keep your boilers in finest condition. If you have a large plant where cleaning goes on most all the time, think you had better own this machine.



Weinland Steam or Air Driven Mechanical Cleaner at Foos Mfg. Co., Springfield, Ohio.

Tell us your scale troubles. We will tell you the remedy, and let you try a Weinland Cleaner free to prove our statements. If it isn't what you want, you can send it back.

THE LAGONDA MFG. CO., Springfield, Ohio

MAKERS OF LAGONDA AUTOMATIC CUT-OFF VALVES, RESEATING MACHINES AND TUBE CUTTERS.

New York Philadelphia Pittsburg Chicago San Francisco Birmingham Toledo London

A Powerful Little Device for Elevating, Conveying and Transporting Liquids—

The Garfield Ejector

Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

Note the straight pipe connections making it desirable for elevating water from deep driven or drilled wells.

Positive in Its Work and Nothing to Get Out of Order

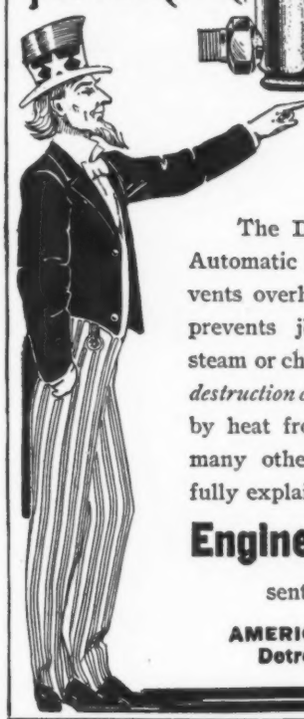
You cannot afford to be without it. Write for complete description. Large Catalog sent free.

The OHIO INJECTOR CO.,
The World's Greatest Injector Manufacturers,
WADSWORTH 110 Main St. OHIO, U. S. A.

No Freezing Here

The Drip Cock prevents it

U.S. Automatic Injector



The Drip Cock of the U. S. Automatic prevents freezing; prevents overheating of suction pipe; prevents jet "liming up" when steam or check valve leaks; *prevents destruction of hose on traction engines* by heat from hot water, and has many other exclusive advantages fully explained in our

Engineer's Red Book

sent free on request.

AMERICAN INJECTOR CO.
Detroit, Mich., U. S. A.

The Pull of the "Demon"

The "Demon" on the right of photo showing over 40 times the pulling power of the turbine. Pump pressure 100 lbs. Reproduction of actual test.

It takes a mighty strong twisting force, torque or pull to clean water tubes rapidly and perfectly.

There never was a self-contained water-driven cleaner that could even approach the "DEMON" for power.

Where does the "DEMON" obtain its immense power? Here's an illustration. Press your thumb over the outlet of an open water faucet and see how soon the accumulating pressure of the water forces an opening. *This is the principle of the "DEMON."*

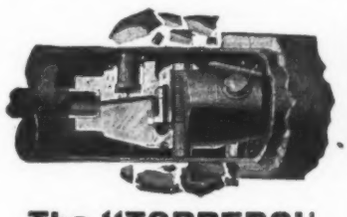
After trying the above hold your thumb a half inch or so below the opening of the faucet and you discover the pressure is slight in comparison with the previous experiment. *That is the principle employed in every turbine cleaner.*

The "DEMON" uses every ounce of pressure directly upon rotary pistons. The water *must* rotate the pistons (and the cutter head) before it can escape. With a 3" piston area and 100 lbs. water pressure it means 300 lbs. pull which reduced to practice causes a rapid crushing of all scale as it is caught under the steel roller cutters. Send for free trial proposition and don't fail to read our folder No. 54 "Demon Cleaners vs. Other Cleaners," or No. 56 on "DEMON" curved tube cleaner.

The "TORPEDO" holds the undisputed lead in the fire tube cleaner class.

Just to show you that this cleaner can save you money—lots of it and it is the best and safest cleaner you ever saw, let us send you one on free trial. If you are satisfied it will pay you 200% or more on the investment buy it, if not send it back.

Our circular No. 30 gives some interesting facts on cleaners. Want one?



The "TORPEDO"

THE "TORPEDO"
Removes all scale from tubes of fire tube boilers.
Saves 11 per cent of fuel for each 1 16 inch of scale
Prolongs life of tubes.
Saves compound.
Centers itself in tube
Strikes same in every direction.
Stroke limited and cushioned
Does not hammer but vibrates the tube.
Is absolutely safe and easily operated.
Has but one moving part.
Will last a lifetime.

The General Specialty Co., 887 Niagara Street, Buffalo, New York.

Shultz Aqua Waterproof Belting

will do your work and do it right in damp places, or where exposed to steam

Aqua leather as well as the cement is absolutely impervious to surrounding conditions. The plies won't separate from moisture.

OIL-STEAMPROOF "Aqua" WATERPROOF

Tell us your belt troubles. Get an Aqua Belt for 60 days free.

SHULTZ BELTING CO.
ST. LOUIS, MO.

NEW YORK BOSTON (26-A) PHILADELPHIA

SAGINAW MANUFACTURING CO.,
SAGINAW, MICH., U. S. A.
MANUFACTURERS OF
GILBERT WOOD SPLIT PULLEYS.
New York Branch, 88 Warren Street.
Chicago Branch, 32 South Canal Street.
Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.

RHOADS LEATHER BELTING

Judge It By Its Work

J. E. Rhoads & Sons
PHILADELPHIA 12 N. THIRD ST. NEW YORK 40 FULTON ST.
BOSTON
HAMBLET & HAYES CO., EASTERN AGENTS, 105-111 SUMMER ST.
FACTORY WILMINGTON, DEL.

Robins Laminated Leather Belting

Eliminates The Glue Pot

SOLVES THE BELT PROBLEM.

The Scientific Principle:
Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

The Positive Result:
A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

Write for Circular No. 2 giving detailed description.

ROBINS NEW CONVEYOR COMPANY

NEW YORK, 38 Wall Street. *FACTORY,* 168 Duane Street, N. Y. *CHICAGO,* Old Colony Building.

BELT HEALTH

is as much dependant on cleanliness as is yours and mine. Belts that have been **doped** for years with gummy, sticky nostrums are **sick,** and **can't** do a good day's work no matter how hard you try to make them. There's no life in them, no **grip,** they are **thick** and **heavy,** and the only remedy is

OXoilOX

nature's belt food, made from the hoofs of cattle. It drives out this old gummy stuff; leaves the belts soft, tough, and clean. Then they **have** life and health. They cling so closely to pulleys that all air is excluded and the vacuum thus formed enables a belt to run slack at its full capacity without slipping. Start **new** and **right** with **OXoilOX.**

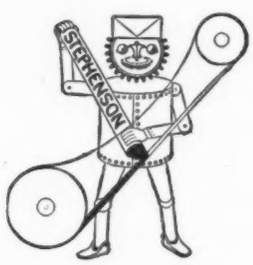
FREE

F. S. WALTON CO., Philadelphia, Pa. Gentlemen: Kindly send us, free of all charge, a sample can of OXoilOX, the perfect belt dressing.

NAME ..... NAME OF FIRM .....
ADDRESS .....
NUMBER OF BELTS ..... AVERAGE SIZE .....

F. S. WALTON CO. Pressers and Refiners of all grades of Neatsfoot Oil. **PHILADELPHIA, PA.**

SAMPLES SPEAK LOUDER THAN WORDS



And there is no **string** to this method of selling our

STEPHENSON
Bar Belt Dressing

Send us 2c. for testing Sample, and say which:

Red Label for Leather belts.
Green Label for Rubber or Canvas.
No **one** kind is good for **all** belts—
you know that.

Of Dealers Everywhere, or

STEPHENSON MFG. CO.
Albany, N. Y.

Agents for England:
J. B. Stone & Co., Finsbury Pavement, London.

The
"RUGGED CONSTRUCTION"

GREAT STRENGTH
AND
LASTING QUALITIES
OF

SAWYER CANVAS
STITCHED BELTING

Recommends it for all heavy transmission and conveyor work

(The belt with the undesirable features eliminated)

SAWYER BELTING COMPANY
29 Lisbon Road **Cleveland, Ohio**

Possibilities of Salary Raising

F. L. RAY

THE possibilities of your securing a raise in salary depend 90% on one thing—upon your securing the knowledge and **training** that will really qualify you to hold a higher position commanding a larger salary. Such training has helped thousands of men in the same way that it helped Frederick L. Ray to advance from work as a machinery erector to power superintendent for the Stanley Rule & Level Company, of New Britain, Conn., and later to superintendent of construction for W. M. Sheehan & Co., New York City. Mr. Ray's earnings have, of course, increased very largely since he became an I. C. S. Trained man—for it was through the I. C. S. that he secured his training. It is **training** that counts. You **must** bring training into your work today if you wish to secure anything above a subordinate position with low wages.

The quickest, surest, and most practical way in the world to secure this training is by the plan of the International Correspondence Schools, an institution backed by a capital of six million dollars and with nearly 17 years' experience in the sole business of providing ambitious men with salary-raising training. You do not have to leave home or your present work. Full details of how this plan can be adapted to **your personal needs and circumstances,** no matter how scant your time, money, or education, will be sent free to any one marking and mailing the coupon below. This puts you under no obligation. If you really want a better position use this coupon **now.**

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 979, Scranton, Pa.

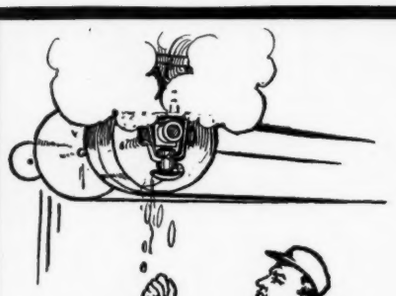
Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
Stationary Engineer	Municipal Engineer	Textile Designer
Gas Engineer	R. R. Construc. Eng.	Bookkeeping
Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name _____

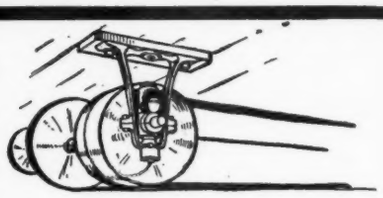
St. and No. _____

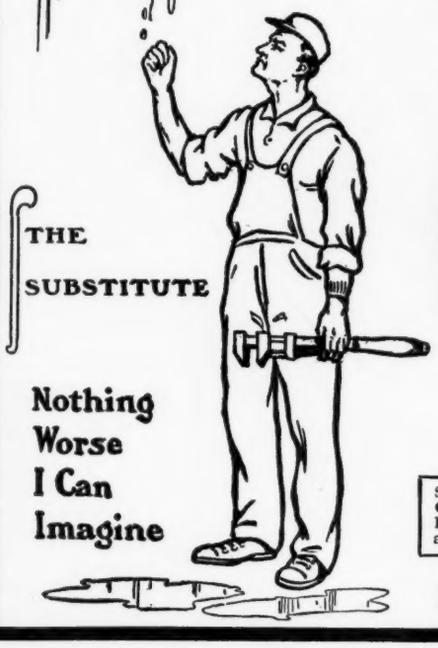
City _____ *State* _____



THERE IS ONLY ONE

ALBANY GREASE





The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.

Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

NOTHING EASIER
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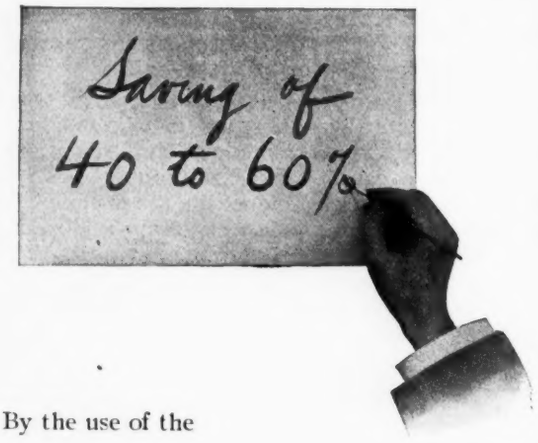


By the use of the

Latest **Improved**

ROCHESTER

Automatic **Lubricators**

you can save anywhere from 40 to 60% of the amount of oil you used to use with the old hydrostatic cup. This alone will soon pay for the lubricator and then think of all the other advantages. Send for a catalog and learn why our lubricators are so generally used.

Greene, Tweed & Co.
109 Duane Street **New York**

TRADE MARK REGISTERED IN
NON-FLUID OILS
UNITED STATES PATENT OFFICE

$1.00's Worth Of NON-FLUID OIL Affords More Economical, Cleanly And Efficient Lubrication Than $3.00 To $5.00 Worth Of Oil Or Grease.

These hot days ordinary oil runs through the bearings like water, and grease—soft and sloppy from the heat—is little better. Neither will stay where put—distributed over the bearings—but spatters over the machine. For this reason, grease makers advise the use of different grades of grease at different seasons.

NON-FLUID OILS combine the full lubricating value of the best fluid oils with the cleanly and lasting properties of greases, but eliminate the disadvantages of both.

Every Particle Of Every Drop Lubricates.

Send For Free Sample.

ORIGINATORS AND SOLE MANUFACTURERS
The New York & New Jersey Lubricant Co.
DEPT. A.
14-16 Church St., New York City.

We Challenge You

to find a bearing in your entire plant which Mica Flake Lubricant will not keep cool—or a hot bearing which Mica Flake Lubricant will not cool while running! Our challenge is contained in a small envelope sample, freely offered for demonstration purposes, of

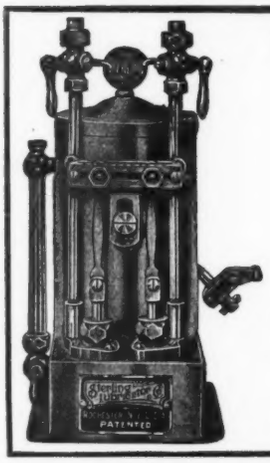
Mica Flake Lubricant

Do you accept our challenge? Send for the test sample! Mica Flake Lubricant is radically different, in principle and performance, from Graphite or any other lubricating material.

Keeps the metal bearing surfaces actually apart—reduces friction—cools hot journals—lengthens the life of your oil—saves costly delays and break-downs—increases operative efficiency!

Mica Flake Lubricant is pure Mica—pure white—will not discolor or damage fabrics. Write for literature, prices, and the test sample!

THE UNITED STATES MICA COMPANY,
238-240 LaSalle Street, Chicago, U. S. A.



FORCE FEED MEANS LOW OIL BILLS

The Sterling Force Feed Lubricator actually saves 40% to 60% on oil bills and furnishes the most perfect known lubrication. It supplies oil as the machine needs it. *Catalog?*

STERLING LUBRICATOR COMPANY,
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The Absolute Zero of Friction is Reached With

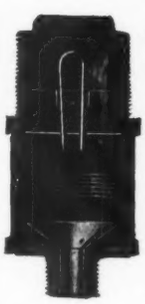
DIXON'S FLAKE GRAPHITE

In the bearings it eliminates cutting and seizing in the cylinder it assures a smooth valve motion and uniform steam distribution.

Ask for a free sample can 94-C

Joseph Dixon Crucible Company,
Jersey City, N. J.

The "Philadelphia" Grease Cup



Automatic application of grease to the bearing without the use of spring compression. : : : :

Nature Supplies the Feeding Force in the Form of Compressed Air. : : : : : :

With many thousands of the "Philadelphia" Grease Cups in successful operation, on machinery of almost every description, we offer a system of lubrication which, for simplicity, cleanliness, economy, reliability and efficiency has no equal.

The "Philadelphia" Cup is not merely "as good as any other:" IT IS THE BEST, and we are prepared to prove our claim for actual superiority. There are more reasons for its practical success than we have room to mention here.

Write for catalogue and full information

The Philadelphia Lubricator & Manufacturing Co.
The Bourse (Exhibition Dept.), Philadelphia, Pa.

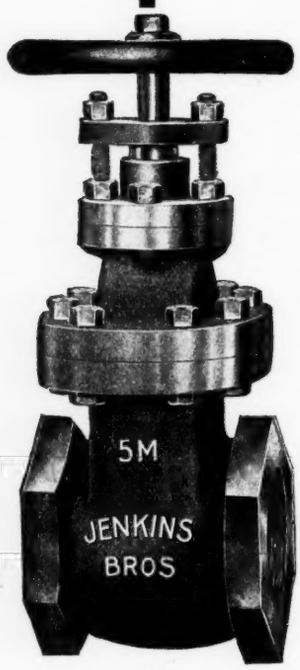
20 DAYS' TRIAL

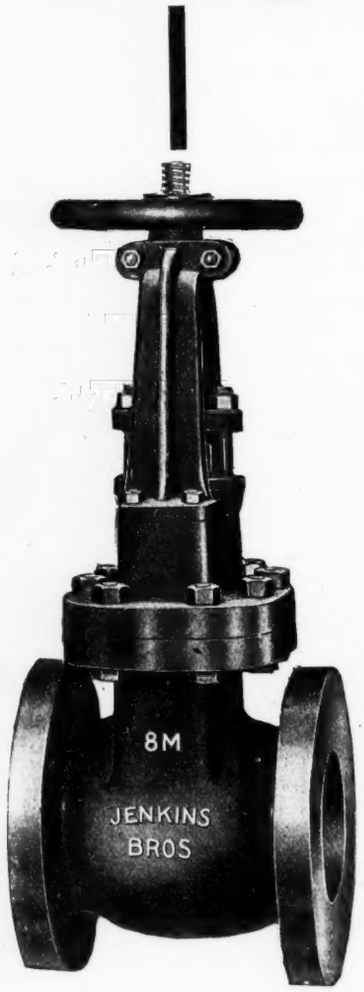
We don't ask you to blindly buy a Detroit Lubricator. We want you to *know* just how good it really is before you pay us a cent for it. If for any reason you don't like it, send it back at *our expense.*

Could any offer be more liberal?

Catalog?

DETROIT LUBRICATOR COMPANY,
Detroit, U. S. A.





Jenkins Bros.

Medium Pressure Gate Valves

are designed for medium heavy pressure steam and water service of all kinds. They are intended for 150 pounds working pressure, but like all valves bearing the JENKINS Quality Stamp they possess a **large factor of safety.** We test each to 500 pounds hydraulic pressure. Not only are the castings entirely free from internal or shrinkage strains but the shape and distribution of the metal is such as to insure

The Most Perfect Rigidity And Resistance

to the stresses incidental to the service for which they are intended. The valves are of the double face, solid wedge type, and are made either with Inside Screw, Stationary Spindle, or Outside Screw and Yoke, Rising Spindle. Wedge has grooves which slide smoothly on ribs in body and prevents uneven wear of the faces or *chattering*. Screw or Flange Ends, and with or without By-Pass Valves. Also special valves for superheated steam.

Write for Supplement No. 1.

Jenkins Bros.,

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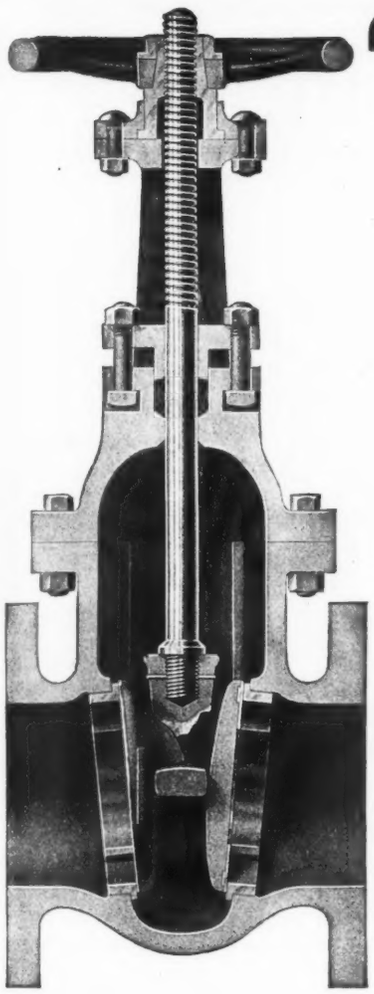

Nelson Valves

Advantages of Nelson Tapered Double Discs

Independently of each other, the Nelson Tapered Double Discs automatically align themselves to any position necessary to make a snug joint, no complicated spreading device being necessary; their flexibility also neutralizes the strain caused by contraction, expansion, shock, or sagging of pipe.

They ride on guides that fit grooves cast in the valve body, and make no contact with the seats until driven home; thus the faces do not scrape and repairs are obviated.

Power is centrally and evenly applied to the discs by a central wedge, easily but securely closing the valve.

As each disc is independent of its fellow, a slight obstruction between the disc and seat on one side does not interfere with a perfect joint on the other.

Accumulation of dirt in the pathway of discs is picked up in the space between them, and when the valve is next opened, is washed away.

The Nelson Type embodies these features, simple, efficient, satisfactory; and has studiously avoided disadvantages common to other types. They are guaranteed, absolutely and expressly.

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Chicago, . . 40 Dearborn Street
Pittsburgh, . 525 Third Avenue
Minneapolis, . . 622 Andrus Bldg.
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DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

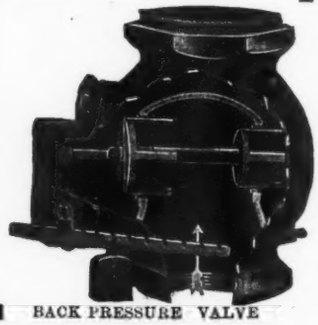
If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

G. M. Davis Regulator Company,
142 Milwaukee Ave., CHICAGO.

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th S.
SAN FRANCISCO—216 California St PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.



BACK PRESSURE VALVE

Would You Trade A Good Dollar For A Dollar With A Hole In It?

Unless you were perfectly willing to get the worst of the deal, you certainly would not. It's exactly the same way when you engineers and power plant men turn over your good money for poor valves and pipage equipment.

You are getting "something" with a "hole" in it!

We call your attention to the unimpeachable products made by us. Products without a flaw—sound clear through.

Valves, Tuyeres, Tuyere Cocks, Traps, Regulators, etc., etc.

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PITTSBURGH NEW YORK BOSTON
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Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.

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THE ONLY METAL POLISH

that works quick and easy and keeps its lustre. Holds old trade and makes new. IT DOES NOT DETERIORATE. Established 16 years.

3-Ounce Box for 10 cts. 5-Pound Pails, $1.00

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GEO. W. HOFFMAN, Expert Polish Maker,
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Branches—New York, Chicago, San Francisco.

The Roller Toggle of the Akron Clutch

Consists of two forked levers pierced with holes in which are lodged three steel rollers.

When the levers are perpendicular to the shaft these rollers press with immense force on the friction discs. Circular for full description.

Successors to the Akron Clutch Co.

The Williams Foundry & Machine Co.
Akron, Ohio

Collin Steam Pressure Regulating Valve

Insures Continuous Perfect Regulation

It MAINTAINS any desired pressure, regardless of variation in boiler pressure. Main valve is balanced by pressure and WILL NOT become cut. Controlling valve is OUT OF PATH of initial steam. It is very simple in design, WITH FEW PARTS and can be easily taken apart. It has no stuffing box or dash pot, requires no packing and is SELF-CONTAINED. *Write today for Illustrated Booklet No. P-B.*

We also manufacture a line of high grade Water Gauges, Gauge Cocks, Gate Valves, and Heavy Bronze Fittings

The Ohio Brass Co., Mansfield, Ohio, U. S. A.

32 Cortlandt St., New York 277 Dearborn St., Chicago 10 North 4th St., St. Louis 138 Front St., San Francisco

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The Seat Absolutely Protected

from wear, never leaks or requires regrinding.
Get the **Homestead Valve** *Booklet.*

Homestead Valve Mfg. Co.,
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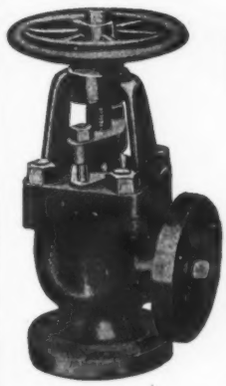
Set The Pressure And Pocket The Key

The Mason Reducing Valve

will maintain just that pressure till you are ready to change it. *Catalog?*

The Mason Regulator Co., Boston, Mass.



Manufacturers of the

EDWARD VALVE

For High Pressures, Superheated Steam and Water.

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Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,
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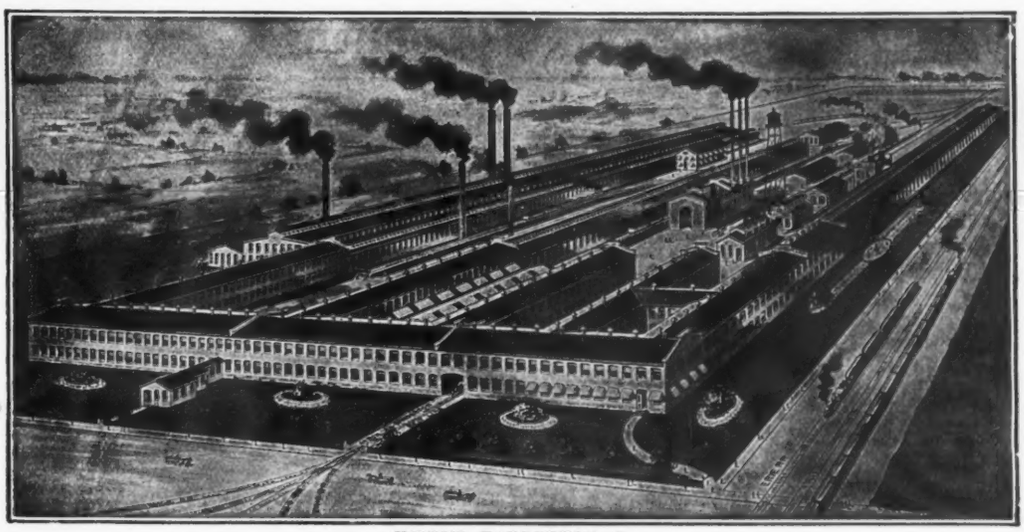
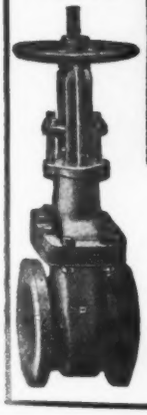
PITTSBURGH IRON BODY GATE VALVES

ALWAYS SPECIFY **P** VALVES AND FITTINGS.

have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made



WORKS, BARBERTON, O.



ALWAYS SPECIFY **P** VALVES AND FITTINGS.

They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

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General Offices and Works: BARBERTON, O. We Manufacture all kinds of Valves and Fittings.

When You Buy Gate Valves—Buy WILLIAMS

You should be ever so particular about the kind of a gate valve you buy. Buying valves because they are cheap is mighty poor economy as they are a source of endless trouble and many repair bills. When again ordering valves, specify—Williams. It's a mark of Quality and your protection against valve troubles. If your requirements call for a gate valve to stand 20 pounds working pressure—please remember that the

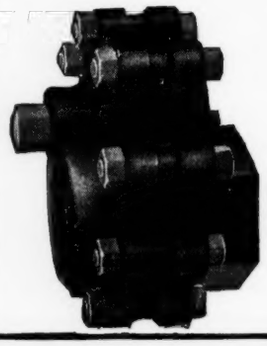
Williams Double Disc Gate Valve

will fill your needs perfectly no matter how severe the service may be. This valve has two discs and seats—a double protection against leakage and will take pressure from either side. Of excellent design, heavy construction it is not effected by the strains of expansion or contraction and will therefore stand long and severe usage. It is the only valve that can be repacked under full pressure of steam or liquids without any danger of being burnt or scalded in the operation.

Be safe and order Williams Valves.

THE D. T. WILLIAMS VALVE COMPANY,
904-910 Broadway, CINCINNATI, OHIO.

EVERLASTING BLOW-OFF VALVE



Straight-through flow. No stuffing-box. Easily operated. Self-cleaning; self-grinding seats. Easily repaired. Send for descriptive booklet and prices.

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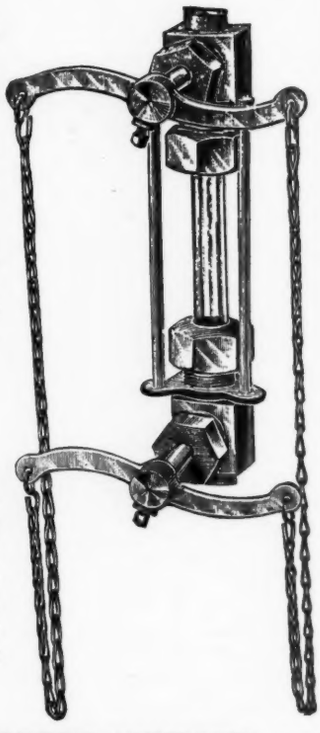


A quarter turn shuts or opens it.

It is made of the finest materials, in *generous proportions*.

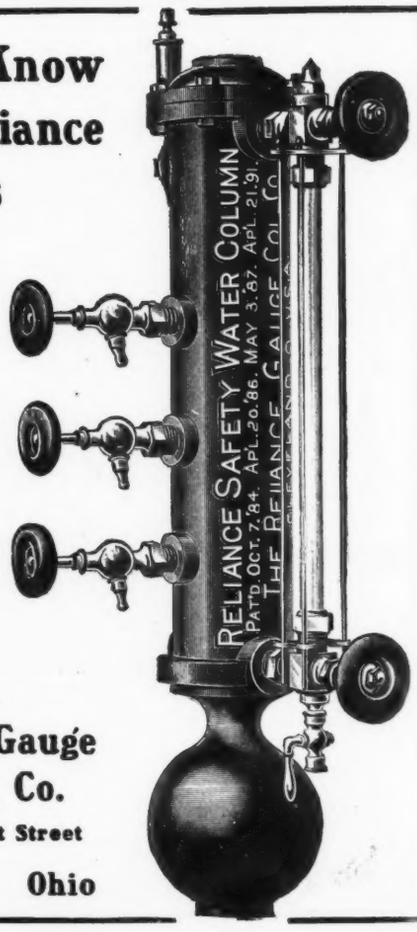
If the glass breaks, a pull on the chain shuts off the steam and water. You know the old way, 'twas self-torture.

Beware Of Substitutes

There is only one genuine "P. B. H." Quick Closing Water Gauge. Insist on the name. We'll gladly send you one for a 30 days' free trial; *you* to be sole judge. *Circular?*

THE PAUL B. HUYETTE COMPANY, INC.
2025 BETZ BUILDING, PHILADELPHIA.

If You Know The Reliance Columns



you know that more boilers are fitted with them than all other kinds combined—if you don't know them you had better follow the example of this overwhelming majority.

Ask for Catalog.

The Reliance Gauge Column Co.
75 E. Prospect Street
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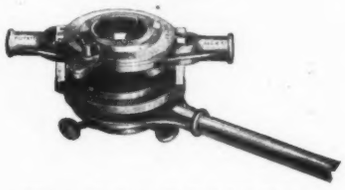
"BEAVERS" are the proper die stocks for use about factories

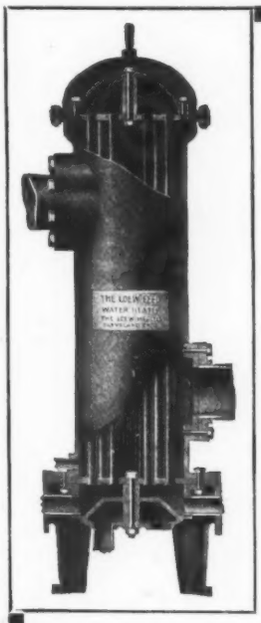
BECAUSE they are built on the easy working principle, enabling one man to thread any size pipe without calling for help.
Each Stock threads all sizes of pipe within its range without changing dies so you have no loose parts to carry around or get lost or misplaced.
And consider the time you save by not having to change dies.
They are a time proven success and of such practical advantage in saving time and labor as to compel their use from an economical standpoint once you realize it.



"Beaver" 1" to 2" Ratchet Stock.

Made in all sizes ¼" up.
Sold by all Jobbers subject to 10 days' trial.
We would like to send you descriptive matter.

THE BORDEN COMPANY
WARREN, O.



It's Like Finding Money

to install the LOEW FEED WATER HEATER. It gives the exhaust steam a *financial value* and reduces fuel bills about 15%.

Some distinctive "Loew" advantages are: The thorough mixing of the water, thus equalizing the temperature. The 6-pass feature, which means that the water passes *six times* through the exhaust steam. The absence of unequal expansion or strain, the ease of cleaning and the total elimination of leakage.

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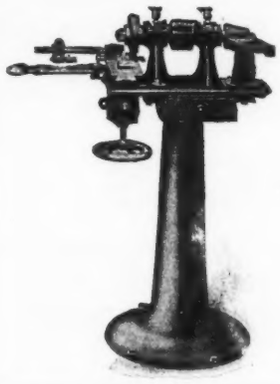
Cleveland, Ohio.



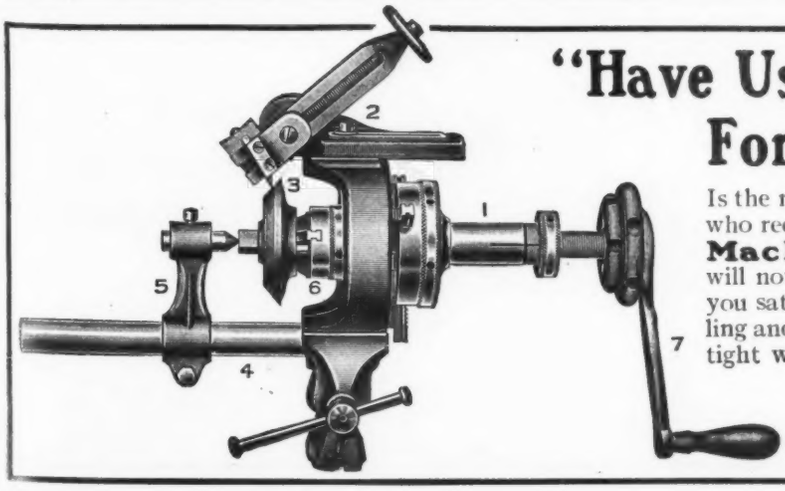
DEBUT

It is needless to say that steel pipe requires a sharp, properly shaped die to produce good threads. The little machine shown here is the

B. & K. DIE GRINDER

for the correct grinding of the dies. Simple to operate, modern in price, and will save you dollars. Shall we send description?

BIGNALL & KEELER MFG. CO.
EDWARDSVILLE, ILL.



"Have Used One Where Formerly Employed"

Is the reason most commonly given by engineers who recommend or order a **Dexter Valve Machine.** ¶ It's a machine an engineer will not get along without after once using. ¶ Are you satisfied having your valves constantly sizzling and dripping when they can be made perfectly tight without removing them from the piping?

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ALWAYS TIGHT

"M & F" Pattern "Kewanee" Unions are *ideal* for *close work.* No nipples or gaskets necessary. Fewer connections and fewer joints. *Write to-day and learn how to save MONEY.*

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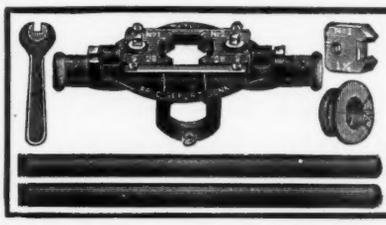

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PIPE MACHINES,
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There's Danger Ahead

for any steam plant using an inaccurate steam gage. The Ashton is the accurate one.

CATALOG "P"

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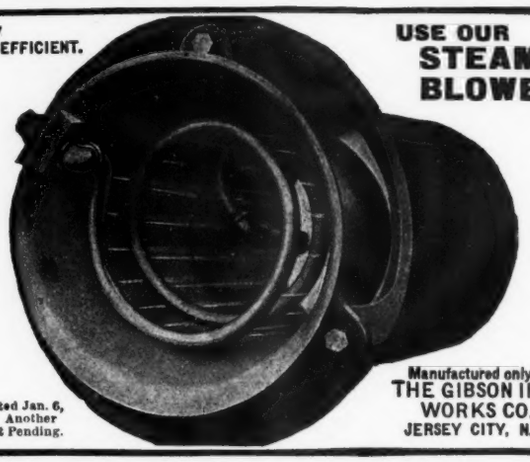
"TOLEDO" Pipe Threading Devices

thread pipe up to 12". ONE MAN can do it quickly and *in any place, in any position.* An invaluable line of tools. Let us tell you about them.

The Toledo Pipe Threading Machine Co.,
TOLEDO, OHIO.

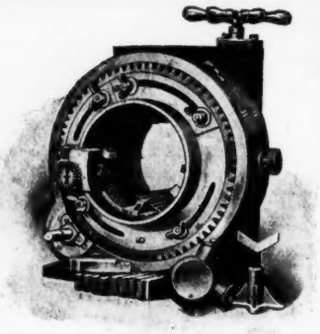
VERY EFFICIENT.

USE OUR **STEAM BLOWER**



Patented Jan. 6, 1903. Another Patent Pending.

Manufactured only by
THE GIBSON IRON WORKS CO.,
JERSEY CITY, N. J.



One Man in a Cramped Place

with a Forbes Patent Die Stock can accomplish more than four men in a ten acre lot with the old style die stock. Moreover he can handle work up to 15" diam. *The catalog tells how.*

The Curtis & Curtis Co.
85 Garden St., Bridgeport, Conn.

"SIROCCO"

(TRADE MARK)

BLOWERS

BUILT ON THE TURBINE PRINCIPLE
SMALLEST BUT MOST POWERFUL
LIGHTEST BUT MOST EFFICIENT

FOR VENTILATING, HEATING, DRYING, COOLING, FORCED AND INDUCED DRAFT. BELT, MOTOR OR ENGINE DRIVEN. FITTED TO STEAM TURBINES.

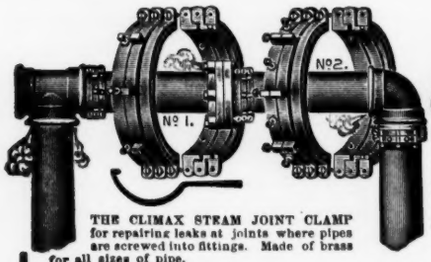
Send for Bulletin 2002A.

Sirocco Engineering Company

138 Cedar St.
New York

Works: TROY, N. Y.

Protected by 37 U. S. Patents

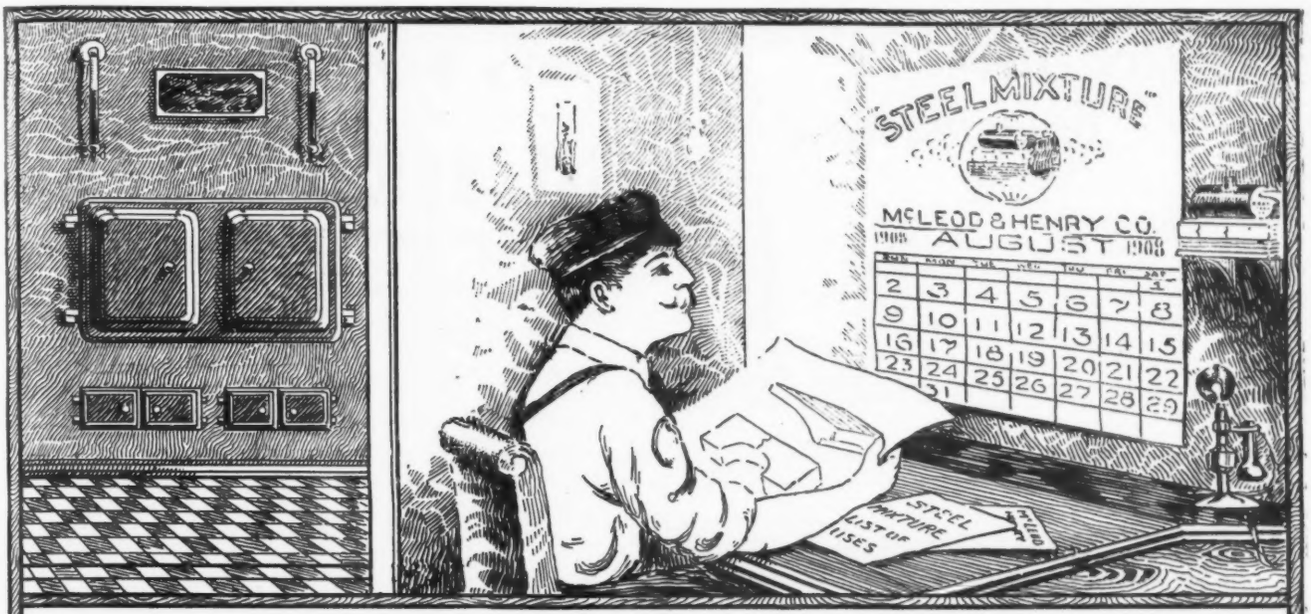


THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

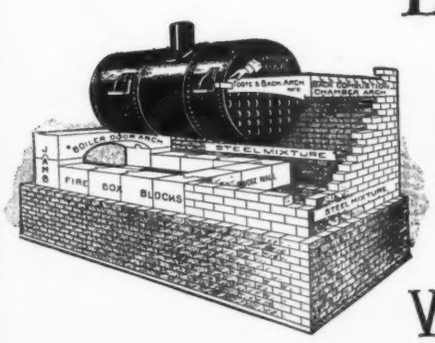
PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES
JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.



HE SEES THE SOLUTION OF HIS PROBLEMS IN

"STEEL MIXTURE"



·BOILER DOOR ARCHES·
·FIRE BOX BLOCKS·
BACK COMBUSTION CHAMBER ARCHES·

WRITE US AND LET US SHOW YOU HOW TO SOLVE YOURS.

MANUFACTURED BY

McLEOD & HENRY CO.

TROY, N.Y., U.S.A.

BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

Black Smoke Is Escaping Coal.

It means that out of every $100 charged to fuel on your books, $15 is actually spent in spreading coal soot over the neighborhood.

Then, too, you have to pay more money to cover that soot with paint and whitewash.

The Wilkinson Automatic Stoker and Smoke Preventer will put an end to this condition.

WRITE FOR A CATALOG.

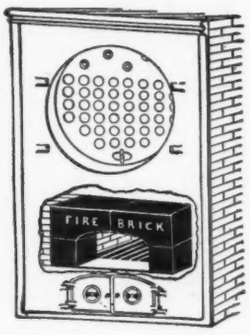
The Wilkinson Manufacturing Co.,
Bridgeport, Montgomery County, Pa.

Every Style
OF
FIRE BRICK

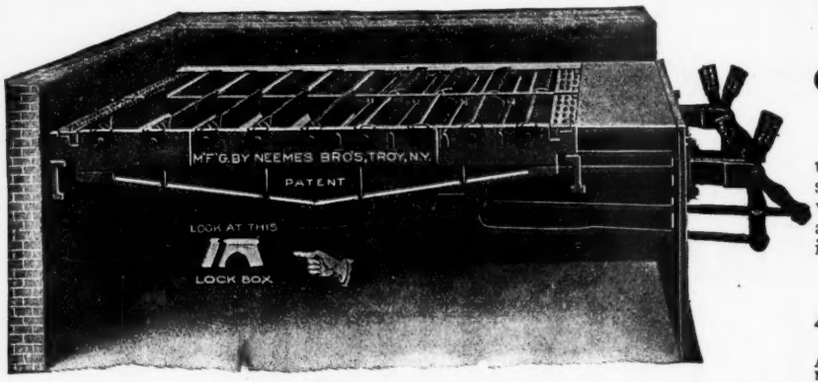
for every style of boiler setting. STRONGEST and most durable made.

NON-SHRINKING

Write for Catalog and Prices



Presbrey Fire Brick Works, Taunton, Mass.



NEEMES BROS.

IMPROVED

Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

NEEMES BROS.,
41-49 Adams St., TROY, NEW YORK

C. W. VAN BLARCOM Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity. BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

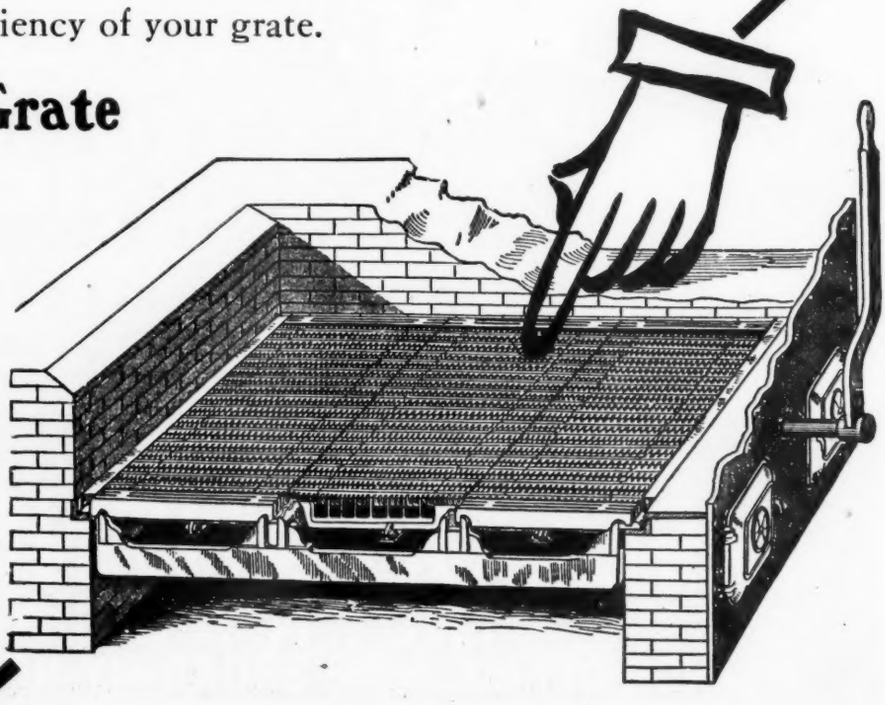
The First Thing To Consider In Power Plant Equipment

is the efficiency of your grate.

The Martin Grate

will save fuel, stokers' wages, equipment repairs and numerous other expenses that in time amount to enough to determine the success or failure of your plant.

Catalog?



The Martin Grate Co.
218 Dearborn St.
Chicago, Ill.

Wing's Turbine Blower

FOR FORCED DRAFT

Most Efficient Most Compact Catalog?

L. J. WING MFG. CO., 90 West Street, NEW YORK

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.

UNITS OF ANY SIZE

PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

CLIMAX SMOKE PREVENTER COMPANY

205 Equitable Building, Boston, Mass.

CO_2 CO_2 CO_2

C-O-Two Tile

FIRE ARCHES

Any Rise, Any Span,
Air Baffle Mixing System

produces

RESULTS

C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

GREEN TRAVELING CHAIN GRATES

AUTOMATIC SELF CLEANING SMOKELESS

GREEN ENGINEERING CO.

COMMERCIAL NATIONAL BANK BLDG., CHICAGO.

GENERAL FOUNDY WORK A SPECIALTY

Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

Jeffrey Coal Handling Machinery

Installed for Speckel's Sugar Refinery

Capacity for handling 120 tons of coal hourly.

Bulletins B and C—free with catalog on elevating, conveying, screening, crushing, mining and drilling machinery.

The Jeffrey Mfg. Company

Columbus, Ohio, U. S. A.

New York Pittsburg Knoxville Chicago
St. Louis Charlestown, W. Va. Boston
Denver Montreal, Canada

Warm Weather Fans

B. F. STURTEVANT CO., Boston, Mass.

General Office and Works—Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

CHIMNEYS

of Concrete with all concrete surfaces protected by a heavy fire clay wall. Write.

WIEDERHOLDT CONSTRUCTION COMPANY

American Trust Company CHICAGO, ILL.

All Working Parts Are Outside

¶ The *Morehead Non-return Steam Trap* operates by and is as unfailing as the force of gravity. There is absolutely nothing inside the tank. Write for full details.

Morehead Manufacturing Company,

1051 Grand River Ave., Detroit, Mich.

Send for Catalog.

Return Steam Trap.

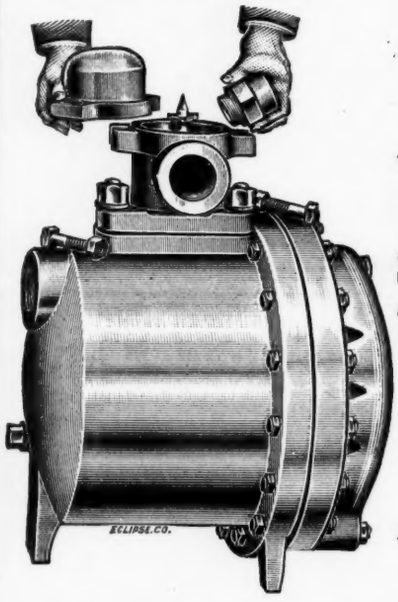
CURTIS SPECIALTIES For particular ENGINEERS

Improved Pressure Regulator
Improved Pump Regulator
Water Pressure Regulator
Expansion Trap
Balanced Steam Trap
Return Steam Trap
Relief Valve for Steam and Water
Separator
Cellar Drainer
Temperature Regulator
Tank Governor and Pump
Damper Regulator
U. S. Ball Cock

JULIAN D'ESTE CO., 24 Canal Street, BOSTON, MASS.

2 HANDS
2 BOLTS
2 MINUTES

4/S



Tells the tale of valve inspection in our

STEAM TRAPS

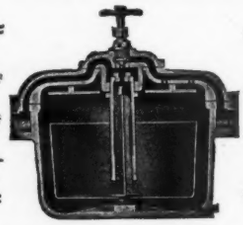
An open bucket inside.

May we send our Catalog "A?"

The Strong, Carlisle & Hammond Co.,
342 Frankfort Ave., Cleveland, Ohio.

Nason Manufacturing Company's
STEAM TRAPS

SPECIFY:
Class B for pressures less than 20 lbs.
Class C for pressures 20 to 70 lbs.
"Sidelug" for pressures 40 to 150 lbs.

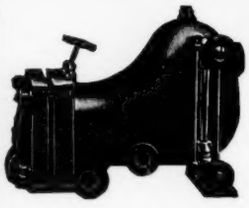


THE TRAP THAT ALWAYS "FILLS THE BILL"

Nason Manufacturing Company's
"Immersed Valve" Boiler Feeder
FOR LOW PRESSURE STEAM BOILERS

As a safeguard against the destruction of boilers through careless handling they are a necessary adjunct. Special Catalog.

NASON MANUFACTURING COMPANY
71 FULTON STREET, NEW YORK



McDANIEL STEAM TRAPS

are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

Watson Steam Pump Governor

should be used on all steam pumps where a fixed discharge pressure is desired.

The construction permits of easy access to the stuffing box for removing packing, and the spring can be adjusted or entirely removed without interfering with any other part of the valve. Any practical man will readily see its advantages.

All our goods are made in our own factory and tested before shipping. We guarantee them to give perfect satisfaction. Established 1878.

Send for Catalogue.

Watson & McDaniel Co.,
148 North 7th Street, Philadelphia, Pa.

The Most Critical Engineers Use

Kitts Specialties

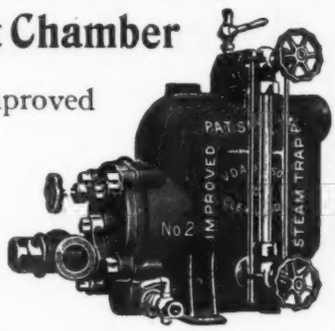
Steam Traps — Pump Governors
Reducing Valves — Fan Engine Regulators
Safety Water Columns — Damper Regulators
Low Water Alarms — Safety Feed Water
Low Pressure Boiler Feeders — Regulators
Vacuum Pressure Reducing Valves

Write For Catalog

KITTS MANUFACTURING COMPANY
Oswego, - New York

The Sediment Chamber

of an Anderson Improved Steam Trap prevents sediment or scale getting into the valve.



Write for the Book.

THE V. D. ANDERSON CO.,
1935 West 96th Street CLEVELAND, OHIO.

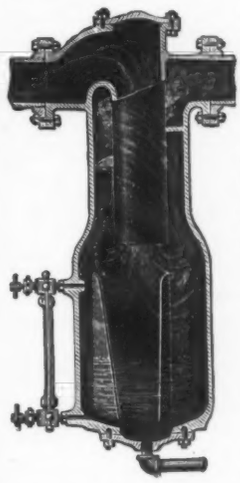
ASK US WHY

we consider the **GEIPEL STEAM TRAP** to be superior to others.

LET US GIVE YOU OUR REASONS

JOHN PLATT & COMPANY
97 Cedar Street NEW YORK

OF WHAT USE ARE BAFFLE PLATES



in a separator anyway?
They don't arrest the water when it comes in a rush except to break it into fine particles that are the more easily carried off with the steam

Therefore the

STRATTON SEPARATOR

has none of them.
It throws the water out of the steam by centrifugal force and lets only the pure dry article pass to the engine.
The STRATTON always does the work when others fail.

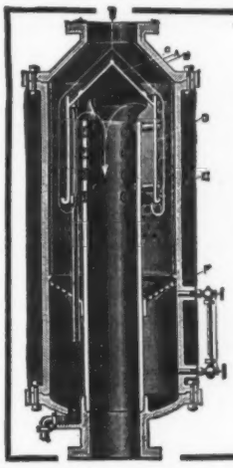
Goubert Manufacturing Co.,
No. 90 West Street,
NEW YORK CITY, N. Y.

GET RID OF MOTOR TROUBLES BY GETTING MOTOR TROUBLES

You can't eliminate motor troubles entirely but you can be relieved of most of their attendant worry if you'll get this new book "Motor Troubles" by E. B. Raymond, Electrical Engineer, General Electric Company.

This book aims to show the best and quickest ways of tracing, locating and remedying direct-current and alternating-current motor troubles and the testing of direct and alternating-current machinery. It hits the mark and will prove its worth time and time again. Send us the price of the book, $1.50, and we'll ship it postpaid. If you don't like it, send it back within 5 days of receipt in good condition and we'll refund your money at once.

HILL PUBLISHING CO.,
505 PEARL STREET, NEW YORK.



DON'T

buy a steam or oil separator without sending for catalog describing

SWEET'S

and then *read* and *think* about it and you'll order one: 6000 in use; deliver steam 99.8 dry; takes out all the oil, that is 99%.

DIRECT SEPARATOR COMPANY
712 South Geddes Street SYRACUSE, N. Y.

BAUM SEPARATORS

ARE BEST for Live and Exhaust Steam.

Positively Guaranteed.

"I take pleasure in stating that this department has used the Baum Separators for a considerable time, and has found them to be all you claim for them and are satisfactory in every respect." —The Superintendent of Public Buildings, Albany, N. Y.

Send for new Catalogue and prices.

Hershey Machine & Foundry Co.
85 Water Street, Boston, Mass. MANHEIM PA., U. S. A.
W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

Harrisburg Feed Water Heaters

Of Pure Seamless Copper Coils. Guaranteed to be the most effective, most durable and cheapest heater manufactured.

Please write for Descriptive Catalog.

COPPER, IRON AND BRASS PIPE COILS AND BENDS OF ANY DESIRED SHAPE

Manufactured by

The Harrisburg Pipe & Pipe Bending Co.

950 HERR STREET, HARRISBURG, PA.

Manufacturers of HIGH GRADE

Wrought Iron

PIPE

BLACK AND GALVANIZED

Accessible Interior

By removing a few bolts, the setting chamber and tube plate of the

Patterson-Berryman Feed Water Heater

may be lowered, exposing the interior without disconnecting the heavy exhaust pipes or disturbing the shell.

Write!

Frank L. Patterson & Co.

28 Cortlandt Street, New York, U.S.A.

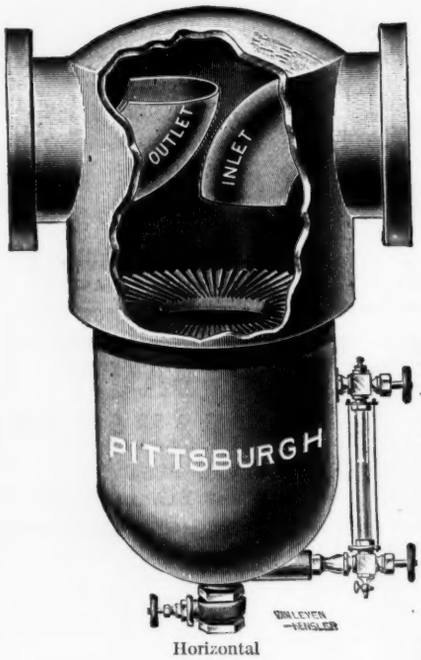
A Whirling Motion

removes the oil and condensation without the back pressure which results when baffle plates, hoods or deflectors are used. Write.

The Gardner Governor & Separator Co.

Quincy, Illinois.

"Pittsburgh" Steam Separators



Horizontal

For Live or Exhaust Steam

Utterly Simple **Perfectly Effective**

Highest Efficiency—
Proved by Laboratory Tests.

No Baffle Plates—
To Cause Spattering Back.

No Contracted Areas—
To Retard Freedom of Flow.

No Small Passages—
To Foul and Clog.

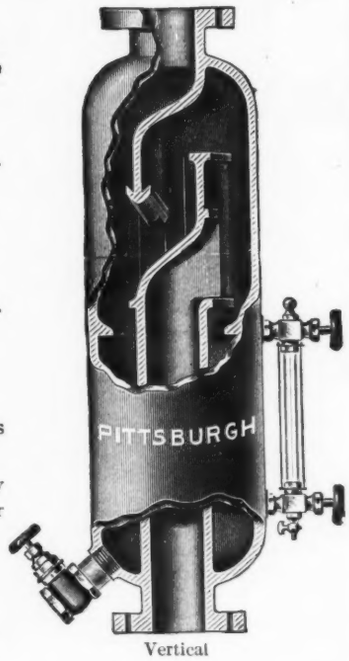
Perfect separation secured by sudden changes in direction of steam flow.

Separated water and oil drained directly away from steam current and into protected receiver space.

Horizontal and Vertical Types

Plain and Receiver Styles

Made in all sizes—Shipped on Guarantee Trial.



Vertical

Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

Our Coal Supply Is Limited---True

but

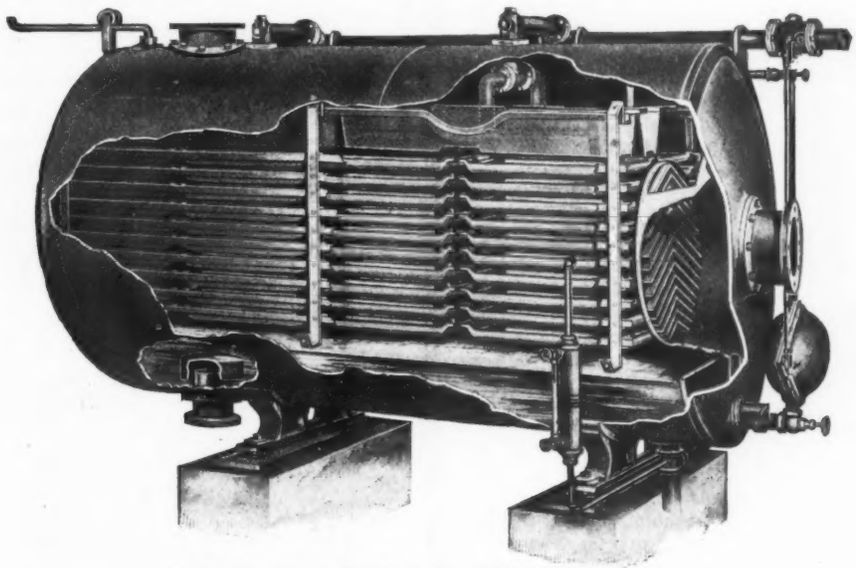
HOPPES

Exhaust Steam Feed-Water Heaters

are busy night and day extending the limits. Their value to the individual, the company and the nation at large is too great for estimation.

Have You A Hoppes Heater In Your Power Plant? No?

Then write for our catalog and prices at once. Install one and it will soon pay for itself by reducing your fuel bill and expense for boiler repairs.

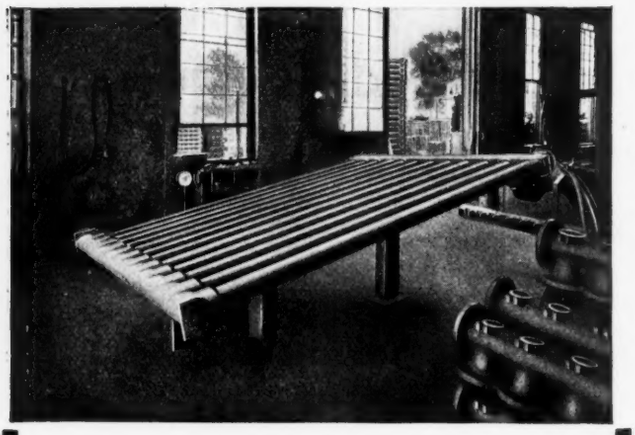


CLASS "R" HEATER—CAST IRON CONSTRUCTION

Hoppes Heaters are built in both Steel and Cast Iron construction and with or without large water storage capacity as may be desired. Every heater is equipped with an efficient oil catcher, balanced automatic feed-water regulating valve operated by drained copper float, and is shipped complete with all necessary fittings ready for piping. Workmanship, material and efficiency GUARANTEED.

THE HOPPES MANUFACTURING COMPANY,

19 Larch Street, SPRINGFIELD, OHIO.



This Is The Way We Test Green Fuel Economizer Sections.

It is not the only test, however. First, when the pipes are taken from the sand in the foundry, they are tested individually to 500 pounds pressure per square inch and thoroughly rapped. This is to save doing any machine work on faulty castings. Then, after they have been machined so that they will fit gauges and templates to less than 1,000th of an inch, the pipes are pressed into the top and bottom headers by means of a powerful hydraulic machine, which is provided with a gauge in order to regulate the pressure to a nicety.

Blank flanges are then bolted over the openings in the top and bottom headers, where the branch pipes are subsequently to be attached, and each section is subjected to a hydraulic pressure of 350 pounds, as shown above. You will notice the pressure gauge over by the wall, and the water pressure pipe at the right hand side of the picture.

After the test, the sections are tilted down and all water blown out. They are then painted and taken to the yard for loading onto cars for shipment.

This is not the end of the testing, however. When the sections are set up at the purchaser's plant they are again subjected to hydraulic pressure to insure that no joints have been injured in transit and that all connections to access pipes are good and tight. These connections are outside the economizer chamber in plain view. You know, therefore, whether your economizer is leaking or not. Leakage within the economizer chamber is to be avoided by all means, since it soon corrodes the metal. When you buy an economizer, it is a good plan to look into these and other points, since you will not want to be bothered with defects after the economizer is in operation.

One thing to remember about the Green Economizer is that over 50,000,000 H.P. are in every-day use, and by consulting users you can find out how small the item for maintenance and repair is. We have accurate records of a large number of plants, and are prepared to make a guarantee on this point. As the fuel saving can be figured out in advance, the customer knows just what the return on his economizer investment will be.

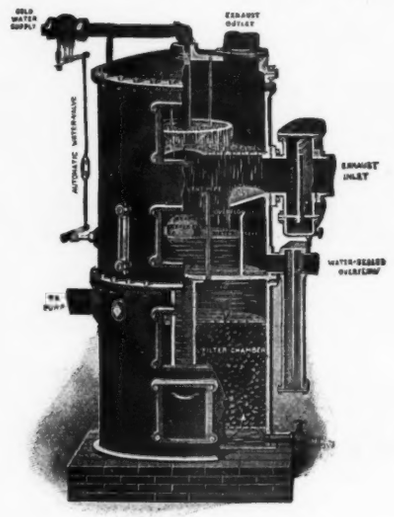
Write for our new Treatise "P 106," also for our special Fan Pamphlets.

The Green Fuel Economizer Co.,
Matteawan, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 156

THE WHITLOCK OPEN EXHAUST Feed Water Heater and Purifier

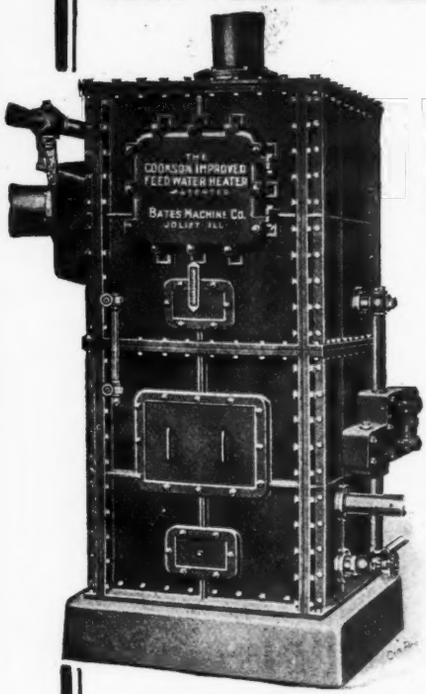


Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

Manufactured by

THE WHITLOCK COIL PIPE COMPANY
HARTFORD, CONN.
New York Office—Singer Building, 85 Liberty Street.

COOKSON STANDARD ALL CAST IRON FEED WATER HEATERS



Highest Temperature and Positive Purification of feed water.

Perfect Separation and Removal of Oil.

Automatic Control of Cold Water Supply.

Dry Steam for Heating Purposes.

Finest Grade Special Fittings.

Lime Catching Pans. Especially Adapted for use with Heating Systems, Dryers, Etc.

Write for our new Heater Catalog.

BATES MACHINE COMPANY
Sole Manufacturers **Joliet, Illinois**

A Profitable By-Product

Your exhaust steam cost good hard cash and it is possible to get the money out of it again if you use

The Otis Tubular Feed Water Heater.

This heater will furnish water to your boiler at 210° to 212° thus saving fuel, repair costs, and exhaust losses.

It also puts an end to scale troubles.

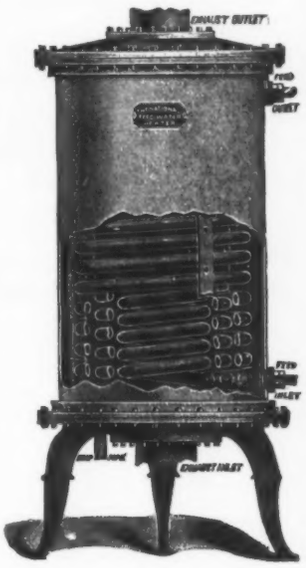
WRITE.

The Stewart Heater Company,

45 E. Delavan Ave., Buffalo, N. Y., U.S.A.

Exhaust Steam Costs Money Make It Work!

Get a National Feed Water Heater—it consists of seamless drawn brass or copper tubing incased in a cast iron shell. It differs from other heaters in that it costs nothing but exhaust steam to operate it. Over 2,700,000 H. P. in use.



Catalog!

The National Pipe Bending Co.,

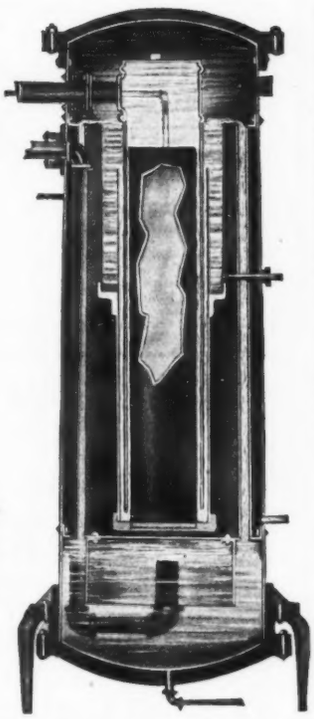
175 Lloyd Street,

New Haven, Connecticut.

120 Liberty Street, New York. 54 High Street, Boston, Mass.

300 Too Much for Scale

Between 200° and 300° the scale forming impurities in water separate out leaving the water pure and safe for the boiler.



The Eclipse Feed Water Heater and PURIFIER

is superior to all other heaters in that by raising the water to 300° instead of 200° it purifies as well as heats.

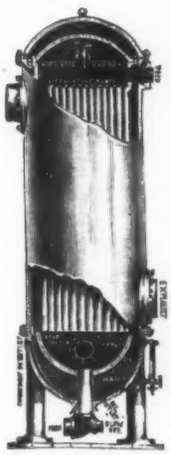
Ask for the book.

The Eclipse Feed Water Heater & Purifier Co.

Oshkosh, Wisconsin.

GIVE AID AND COMFORT TO YOUR BOILER

The Riblet Feed Water Heater



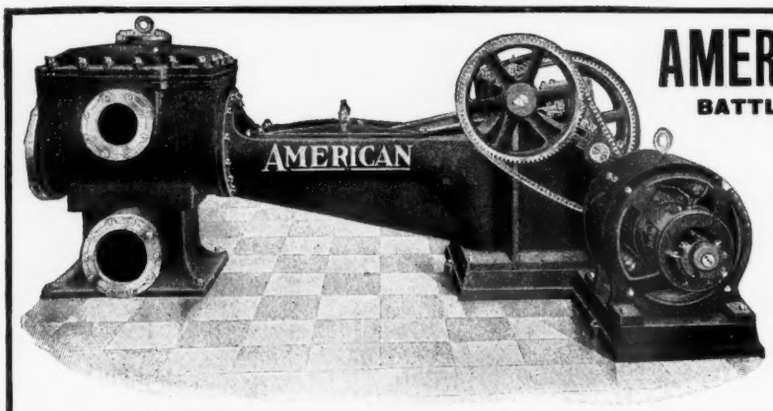
Made In All Sizes to 6,000 H. P.

All its tubes are straight and made fast only at one end thus providing for easy cleaning and safe expansion or contraction.

Ask for the Catalog.

ERIE MFG. & SUPPLY CO.,

1203 PEACH ST., ERIE, PENNA.



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To be simple is to be great.

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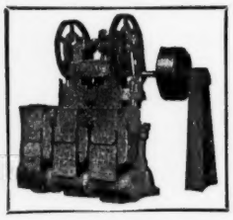

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THE REILLY GREASE EXTRACTOR AND FEED WATER FILTER

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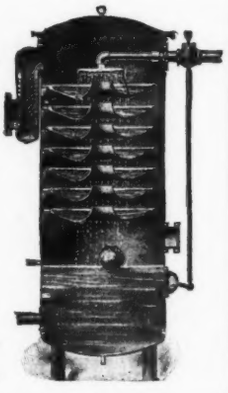
Exhaust steam utilized for heating water for boiler feed or laundry work.

Simple, effective, durable. Tested like a boiler.



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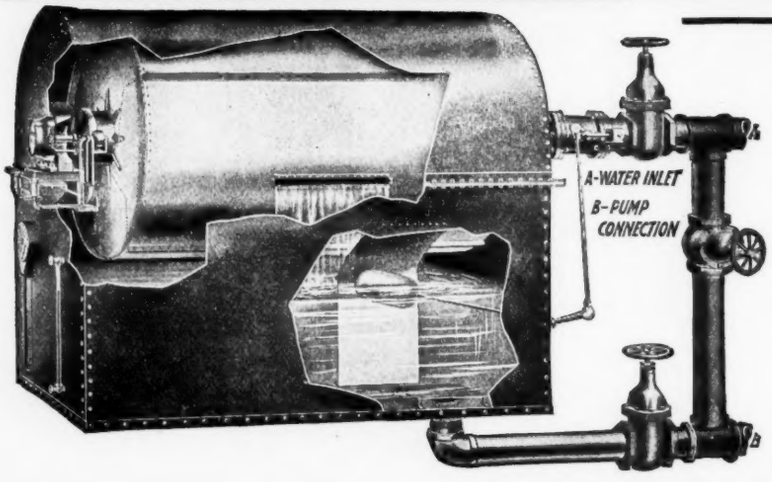

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Is your coal best fitted for your purpose?
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DETROIT METER

Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

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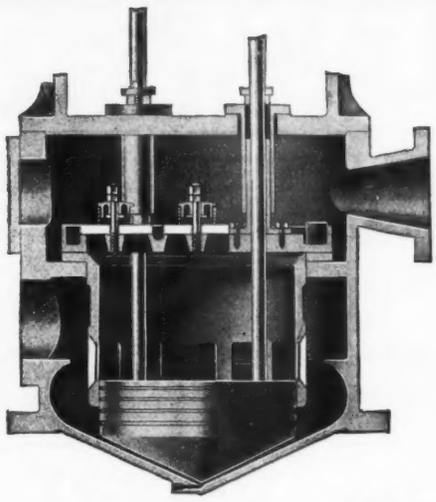

An Air Pump With No Foot Valves And No Bucket Valves

has less to get out of order and to be kept in repair than an air pump which contains such parts.

But this is not the main reason why the Edwards Pump is better by not having such valves. With no foot valves, the air and vapors in the Condenser can flow directly into the pump chamber without let or hindrance. There are no valves to be lifted and no head of water on the valves to be overcome. The air and vapors flow freely and at once into the vacuum created by the descent of the plunger and they are further assisted by the aspirating action of the Condensation injected in above the plunger just before the latter rises and shuts off the ports.

At the end of the stroke the air and vapors are forced out through the head valves, the water passing out first so that no gas is left in the clearance space. Even the clearance space filled with water is reduced to the lowest possible minimum, so that upon the descent of the plunger very little gas can be set free by the expansion of bubbles. Any gas left in the clearance space of the vacuum pump must expand to condenser pressure before more gas or vapor can be taken in

The Wheeler Edwards Air Pump accomplishes all that can be done with separate wet and dry pumps of the ordinary type. For proof of this let us give you references to a large number of installations now operating in this country.

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Steam Pumps

of the Highest Class.

Repairing of Pumps a specialty.

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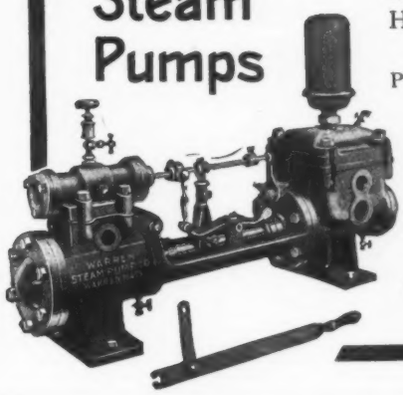

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For Municipal Water Works
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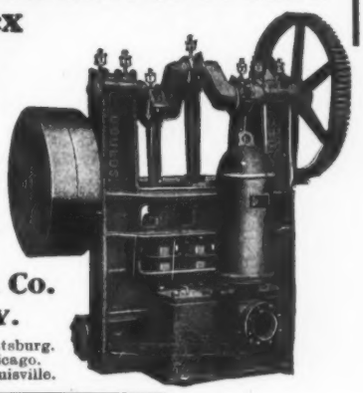
Have fully demonstrated their practicability and efficiency for these important services.



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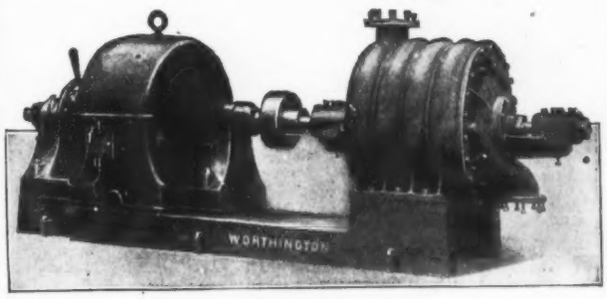

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RELIABLE
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WELL CONSTRUCTED

Require very little attention.
Built to suit your conditions.

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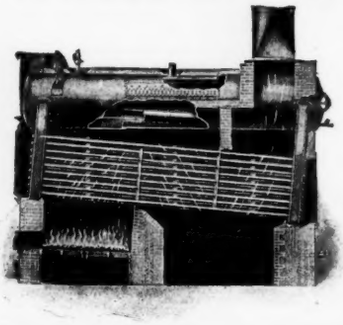

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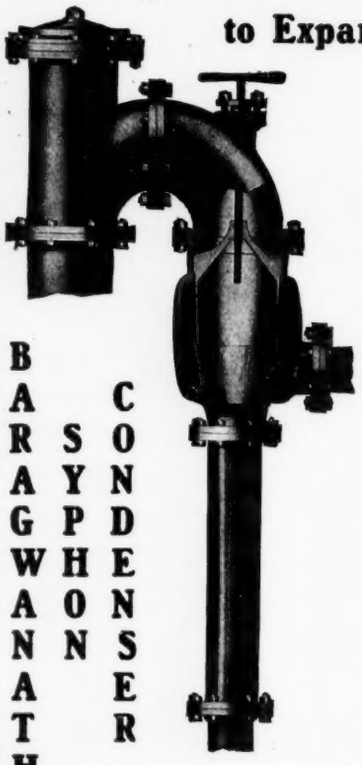

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Nothing is more effective for this purpose than

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It maintains the highest practicable vacuum without aid of air pump and is adjustible for close regulation.

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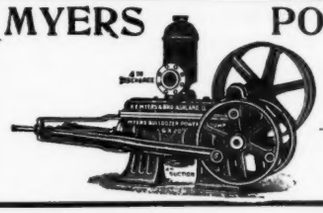

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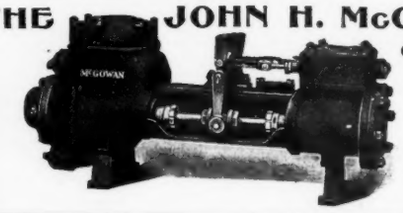

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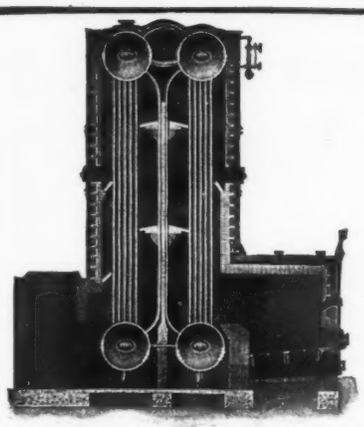

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SAFE, SIMPLE, DURABLE,
ECONOMICAL, ACCESSIBLE

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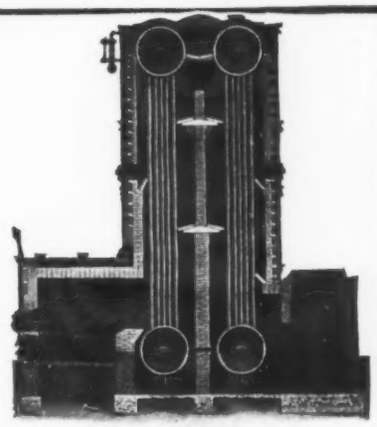

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New York—Pittsburg—Chicago—Denver—San Francisco.

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Greatly increase capacity and permanent efficiency of steam turbines.

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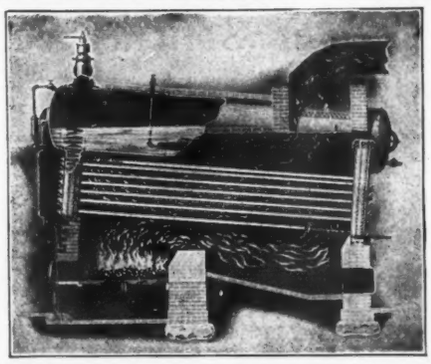

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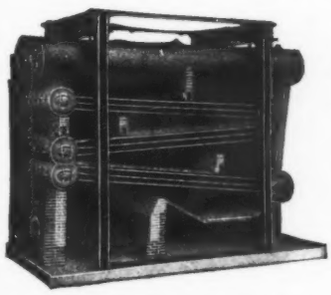

consequently the Vogt Water Tube Boiler is more easily and quickly repaired. Its all steel construction is a guaranteeof durability unequaled in the world.

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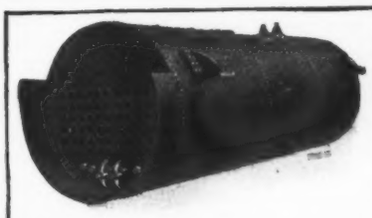

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Are Boilers of CHARACTER

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

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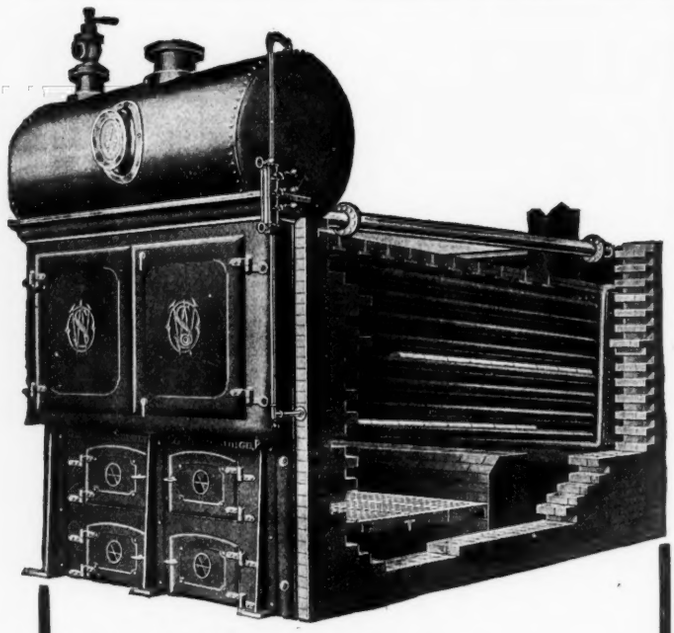

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in any power plant is the boiler system. If you appreciate that fact you will do well to investigate

Our Safety Water Tube Boiler

Built for any pressure from 125 to 300 pounds. Meets all the high duty requirements of modern triple and quadruple expansion and compound engines. Perfect circulation, remarkable economy, and freedom to expand and contract, are features.

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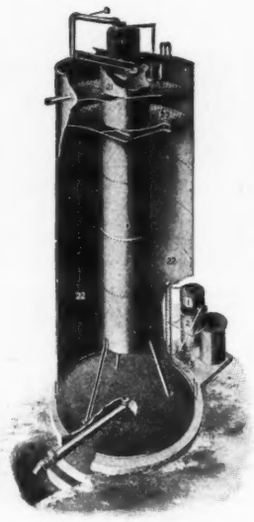
Don't Have Any Scale To Remove

Thus you will save the cost of tube cleaners' time to operate them and damage done to the boiler.



The Bartlett Water Softening System

will furnish, at 1 to 2 cents per 1000 gallons, water so purified that instead of forming scale it will prove an antidote, which will cause the scale, already formed, to rot and fall away from the tubes. Catalog ?

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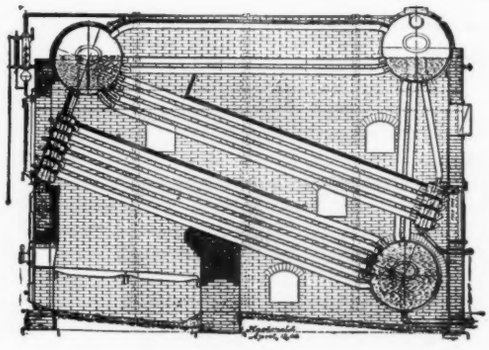

Free expansion of tubes—Perfect water circulation—Dry or superheated Steam—Half the usual number of handholes.

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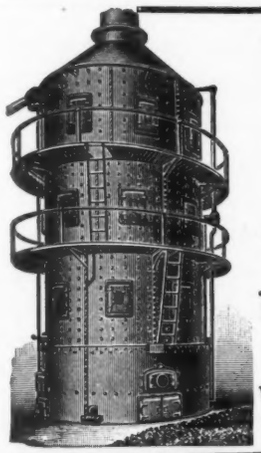
Built in Canada by Robb Engineering Co., Ltd., Amherst, N. S.



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Large heating surface, quick steam generation, fuel economy, absolute safety, strength and durability, simple construction.

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The Fisher Pump Governor works automatically on all pressures up to 8,000 lbs. and guarantees *safety* and *economy*. Used in Hydraulic Service, Air Compressors and all types of Pumps working under pressure. Write !

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Safety
Automatic
Feed Water
REGULATOR

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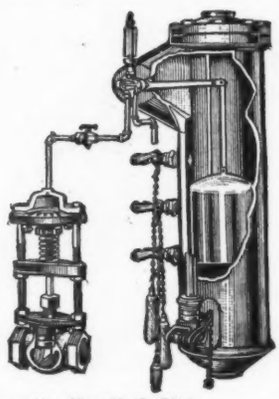

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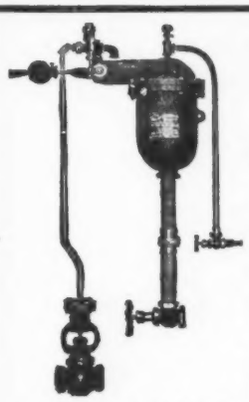

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for steam boilers was the first in the *field*, and has the longest and best record of any of these devices.

Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.
Investigate it and the

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A guarantee from a responsible firm with every machine.

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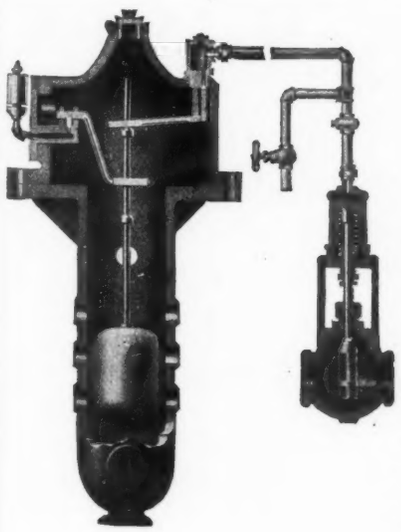

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Just send us your name and address and we will send you by return mail a full description of the safest, most reliable, efficient and economical Feed Water Regulator ever invented.

The "Gould" guarantees *a continuous* feed in exact *proportion to evaporation*, the water level being regulated and carried to any desired point by adjusting a bleed valve. For the sake of your *own safety, greater boiler efficiency* and lowered expenses, WRITE TO-DAY !

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Provides a means of forcing boilers to an evaporation away beyond their rated capacity.

Permits of burning low priced fuel (which cannot be burnt by natural draft) such as screenings, gas works, breeze, saw dust, etc., thereby making a direct reduction in cost of steam. Creates more perfect combustion.

We also make Blowers working by water pressure for ventilating mines.

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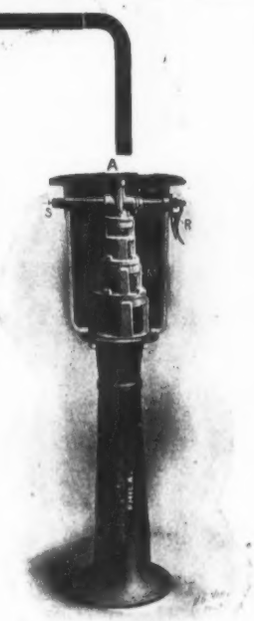

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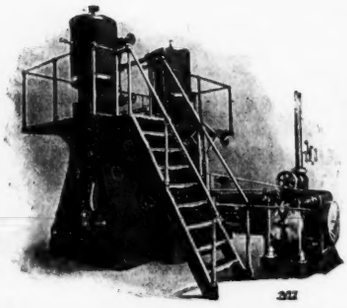

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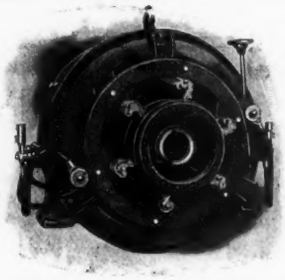

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having nearly 25% more ventilating area than other machines, are the coolest running. They are also furnished with the reaction type of brush holder—the best on the market. Get our catalogue.

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Every type of first class thoroughly guaranteed Hydraulic Jacks for all classes of work are manufactured by us.

Over 400 different types and sizes from 2 to 1000 tons capacity.

Each and every tool guaranteed.

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THE CHEAPEST POWER IN THE WORLD

GAS ENGINES, GAS PRODUCERS
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20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
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Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.
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We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

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1768 Powers St., CINCINNATI, OHIO.

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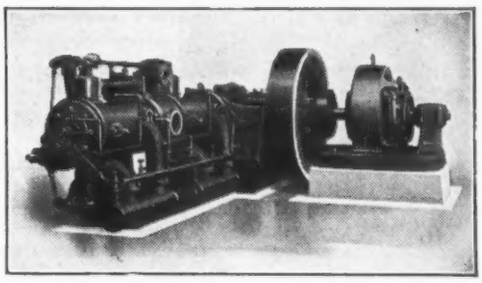

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"The Improved Type"

We guarantee these engines to develop full power on a minimum fuel consumption, to prove cool running, easily governed and free from valve troubles. Five to 375 H.P. designed to operate on Natural or City Gas, Gasoline and Producer Gas. Catalog "G."

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Established 1877
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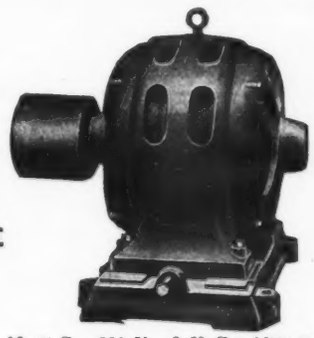

1 TO 75 H. P.

10 H. P., 220 V., 3 H. P., 1200 R. P. M.

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FORT WAYNE ELECTRIC WORKS
WOOD SYSTEMS

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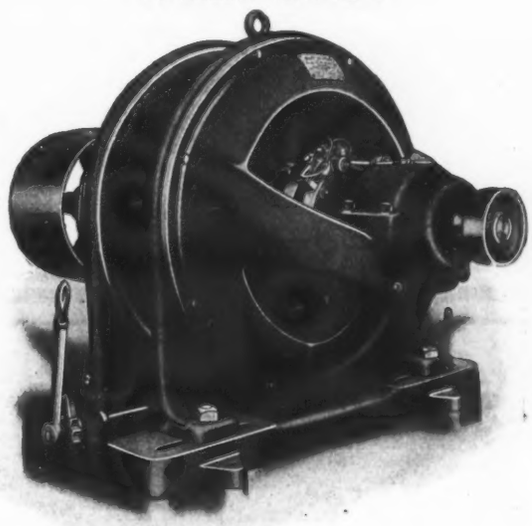

Type TRB, Three-phase 150 K.W. alternator, Form B.

We make Type TRB, Form B multiphase belted alternators in convenient standard sizes, from 50 to 200 K.W. in any standard voltage, that exactly meet YOUR requirements. If you have conditions that are DIFFERENT, tell us. We want to show you how we meet them. **ASK FOR BULLETIN 1104.** 707

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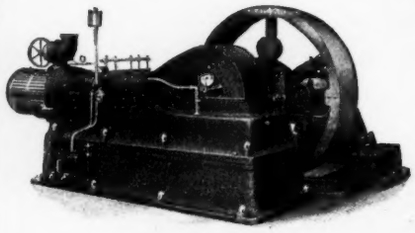
SIDE CRANK
SINGLE and FOUR VALVE



SIDE CRANK TYPE

Skinner Engine Co.,
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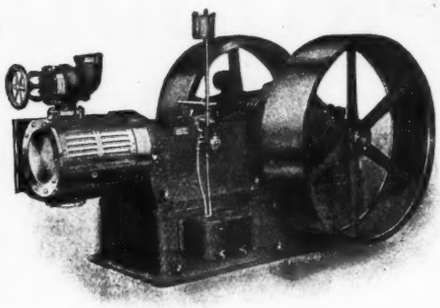

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BUCKEYE ENGINE COMPANY,
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BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION
AND
ABSOLUTELY RELIABLE
CORRESPOND WITH US BEFORE PURCHASING
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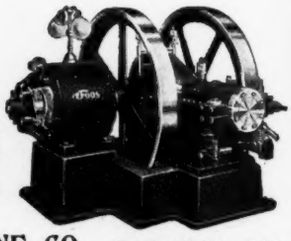
FOOS
PRODUCER GAS ENGINES
ARE MONEY SAVERS
FOR ELECTRIC LIGHT PLANTS

No other power can show the saving in fuel expense. Write for Catalogue K and learn why the Foos has many superior points and can save you money.

Vertical and Horizontal Engines

25 to 500 Horse Power.

Producers built to use anthracite or bituminous coals or lignites. One pound anthracite coal produces one horse-power one hour. Largest exclusive Gas Engine factory in America.



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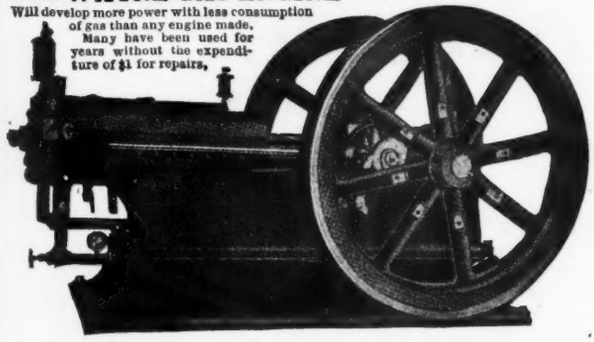
Gas Producers from 35 H. P. up.

Will develop more power with less consumption of gas than any engine made. Many have been used for years without the expenditure of $1 for repairs.



Each engine covered by a positive guarantee. Send for Catalog

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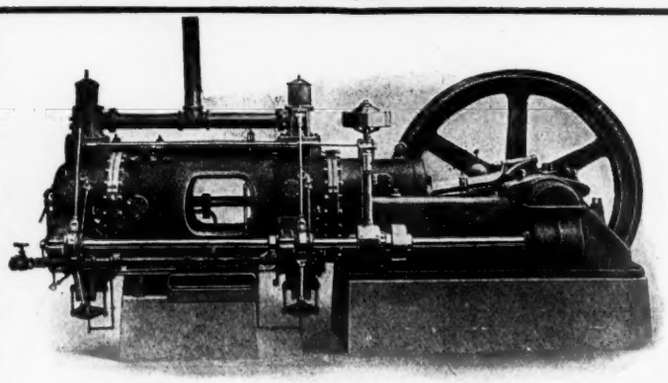

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Horizontal and Vertical
Types up to 700 H. P.

NOT AN EXPERIMENT
Economy and Reliability Have Been Demonstrated by Actual Service

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REEVES ENGINES
MAINTAIN THEIR ECONOMY AND SUPERIOR RUNNING QUALITIES.
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Drive Your Power Plant Auxiliaries With Northern Motors
Power plant auxiliaries require trustworthy power. Northern Motors meet this requirement exactly. You can always rely on your pumps, conveyors, blowers, etc., as far as the power is concerned, if driven by Northern Machines.
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A small saving in first cost, followed by the never-ceasing *trouble and expense* of a poor engine in operation, or *a fair price* at the start, and then **Shepherd Engine Economy.**
Our Catalog will help you to decide.
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Built only by
THE BALL ENGINE CO.
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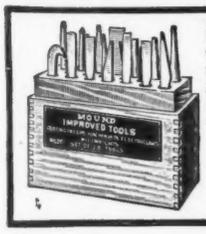

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This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.
No. 20 Set of 20 Tools . . . $4.00.
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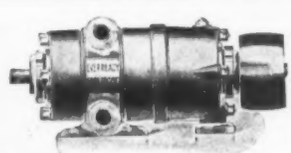
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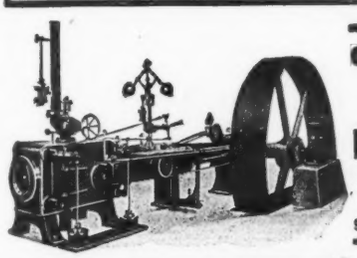
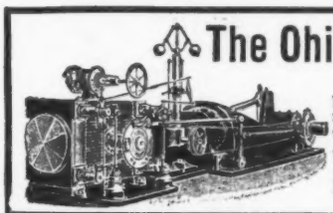

CORLISS ENGINES
Refrigerating and Ice Making Machinery
THE VILTER MFG. CO.
910 Clinton St., Milwaukee, Wis.

The Ohio Corliss Engine

For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.
THE GRIFFITH & WEDGE CO.
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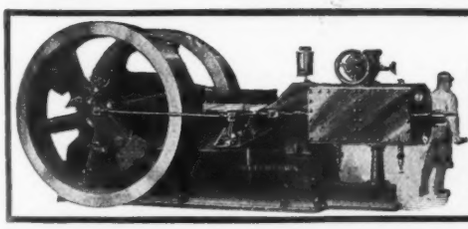
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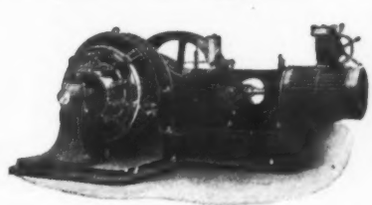
Be Sure That Your Dynamo Matches Your Engine
When they are built expressly to run together your power costs less and is more reliable. *Write*

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ACCURATE REGULATION FOR ELECTRIC SERVICE—AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR
A.H.ALBERGER COMPANY
45 TO 600 H.P. USING NATURAL GAS
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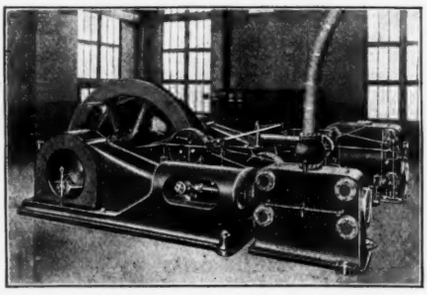
SOLE BUILDERS OF THE

PORTER-ALLEN AUTOMATIC STEAM ENGINE

the use of which insures a high economy in steam consumption and a minimum cost of maintenance.

The design is unsurpassed for simplicity and compactness, while the details of valves and gear, bed-plate construction, etc., are greatly liked by all users.

Adapted to every class of service



Rice & Sargent Corliss Engines

The illustration shows a 400 K.W. Rice & Sargent engine running 150 R.P.M.

DESIGNED AND BUILT BY

PROVIDENCE ENGINEERING WORKS

Main Office and Works PROVIDENCE, R. I.

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ON A MINUTE'S NOTICE

We have for immediate delivery:

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h.p.; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p.; wheel 14-ft. diameter by 33-inch face.

The above are **new** engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11-inches diameter. Wheel weighs 15,000 pounds.

Get busy and communicate with us.

C. H. BROWN ENGINE CO., Inc.

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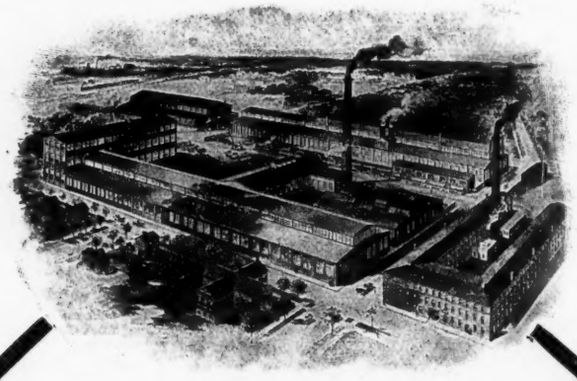

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We build engines for Rolling Mill, Railway, Lighting, and general Power Plant service.

Complete Steam Plant Engineering a specialty.

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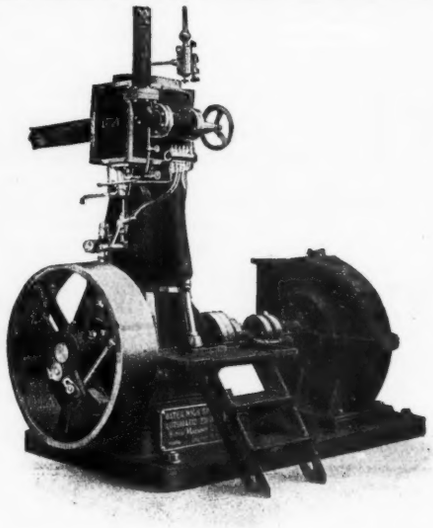

Bates Vertical Automatic High Speed Engine for connection to Pumps. Especially adapted for

WATER WORKS, IRRIGATION

and other places where it is desired to move a large volume of water at small expense.

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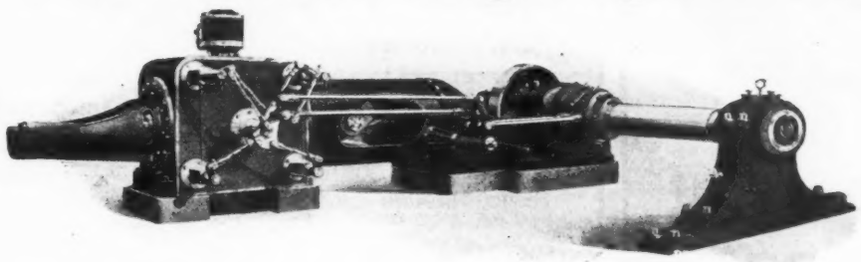
Manufacturers

POWER PLANTS BOILERS

The Perfect High Speed Corliss Engine



We build the only Corliss Engine ever designed possessing every feature of value common to both releasing and non-releasing types. We are able to secure continuously and under all conditions of load, as quick a cut-off and valve opening as can possibly be obtained from the best releasing gear. Our valve travel never varies, and piston speeds up to 900 feet are common to our engines. Catalog? It's free.

Clark Bros. Company, - - Belmont, N. Y.

For Highest Steam Economy

there's not an engine made that can equal the "FITCHBURG." It has perfectly balanced piston valves, closest regulation of speed, lowest possible friction, and retains steam tight valves for 25 years with but one hour's attention a year.

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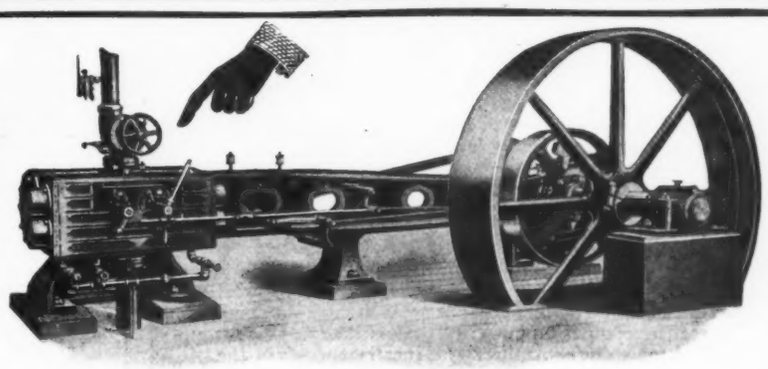

Fitchburg Steam Engine Co.
Fitchburg, Mass.

Geo. H. Conner, 509 Mutual Life Bldg., Philadelphia. E. H. Ludeman & Co., 165 Broadway, New York.
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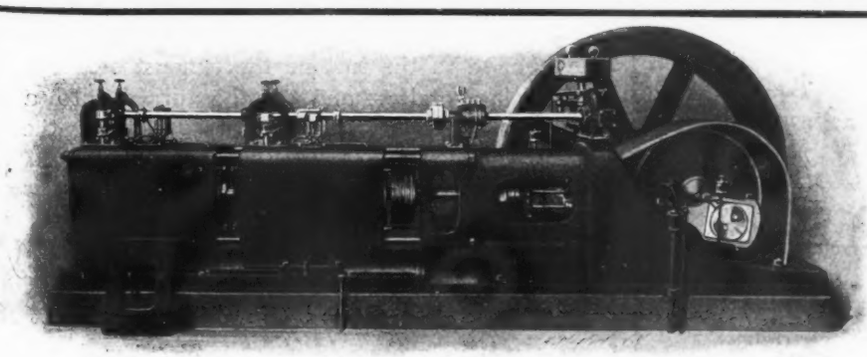
Western Trading Co., San Francisco.



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SHOWING QUICK METHOD OF EXPOSING PISTON AND RINGS.

Simplicity and Accessibility

due to valve gear being all on top and of the simplest possible form; the divided cylinder permitting piston and rings to be exposed in about the same length of time required to remove the cylinder head from most engines; are features found only in the

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Built in 12 types, 72 different sizes ranging from 10 to 2500 H. P., to operate on any of the power gases. We also build a complete line of gas driven air and gas compressors.

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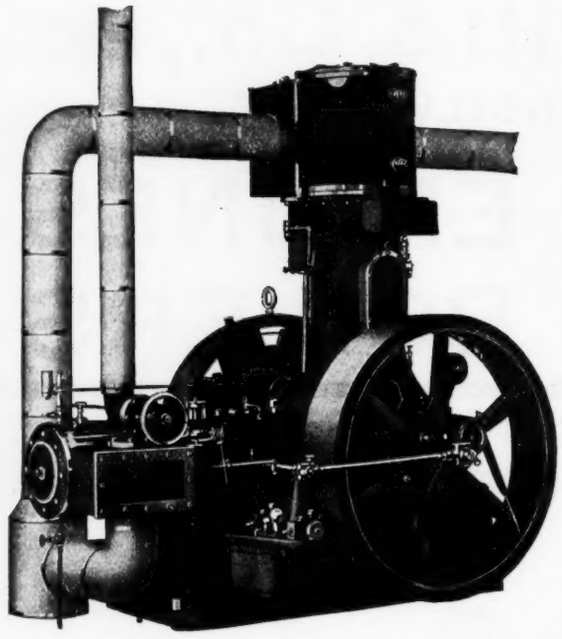
Indianapolis, Mr. F. Louis Egan, 1130 Congress Ave.



The Floor Space of a Simple Engine of Half the Horse Power

A notable achievement in high speed engine building is the novel and highly successful combination of two complete engines—one at right angles to the other—in the American Ball Angle Compound, whereby double the horsepower is installed in about the same space which simple horizontal high speed engines would require.

Great as this space economy surely is, the greatest gain lies in the perfect balance secured by combining these two engines on one crank. Each piston absorbs and completely neutralizes the inertia thrusts of the counterweight necessary for the reciprocating members of the other piston thereby producing so perfect a balanced condition as to eliminate every vestige of vibration.

Never in the history of steam engineering has so smooth a running reciprocating high speed engine been produced.

Write for full particulars.

The
American Engine Co.,

Builders of American-Ball, Simple and Compound Engines; Direct Current Dynamos and Motors; Complete Generating Sets.

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Boston Office, 69 Federal St. 114

Small Curtis Turbine Generators

For Direct Current
20, 25 and 35 kilowatts

These sets consist of a Curtis Steam Turbine, direct connected on the same shaft to a shunt or compound wound General Electric Generator. The turbine is the single stage, non-condensing type with three sets of bucket wheels, mounted on the same hub. Between the wheels are the intermediate or stationary buckets. The nozzles are contained in a separate casting. Steam is admitted through a strainer to the steam chest and is passed through balanced valves operated by the governor, directly to the steam nozzles, thence through the turbine and to the exhaust.

Turbine end view of 20 kw. Curtis Turbine Generator. Speed 4500 r. p. m. 125 volts. Length 5½ ft. Weight 1850 lbs.

These sizes may be arranged to operate at any steam pressures above 80 lbs., and no difficulty is encountered in using steam superheated to 200 degrees F. As no internal lubrication is required in the turbine the exhaust steam is absolutely clean and can be turned into a heating system without risk of clogging the system with oil.

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Principal Office: Schenectady, N. Y.

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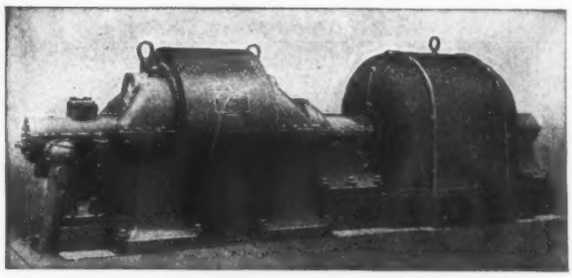
Sales Offices in all large cities.

1791

Convert your waste into profit



Westinghouse Exhaust Steam Generating Unit

You can convert the exhaust steam you are now wasting from non-condensing engines, pumps, compressors, etc., into profitable electric power by installing a Westinghouse Exhaust Steam turbine generating unit. The amount of power it will generate with otherwise wasted steam is surprising, frequently exceeding that produced by the primary engine. It is an easy way to increase the power capacity, without increasing the boiler capacity, of your present plant.

Our engineers are always pleased to make your power problem theirs; address nearest office.

The Westinghouse Machine Company,

Steam Turbines, Steam Engines, Gas Engines, Gas Producers, Storage Batteries and the Roney Stoker

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Cleveland, New England Building.
Atlanta, Candler Building.
Chicago, 171 La Salle Street.
Cincinnati, Traction Building.
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Pittsburg, Westinghouse Building.
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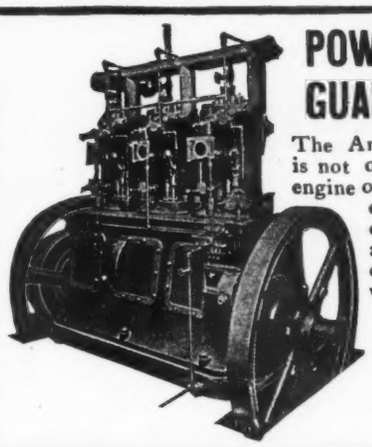
San Francisco, Hunt, Mirk & Co.



POWER COSTS GUARANTEED

The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

Write for Catalogue.

AMERICAN DIESEL ENGINE CO.
11 Broadway, N. Y.

DE LAVAL

De Laval Turbine-Driven Blower.

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electric-Motor Centrifugal Pumps

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QUICK REPAIRS

When Engine Troubles occur, we can repair the damage right in place and save you the trouble of "knocking down" and shutting down.

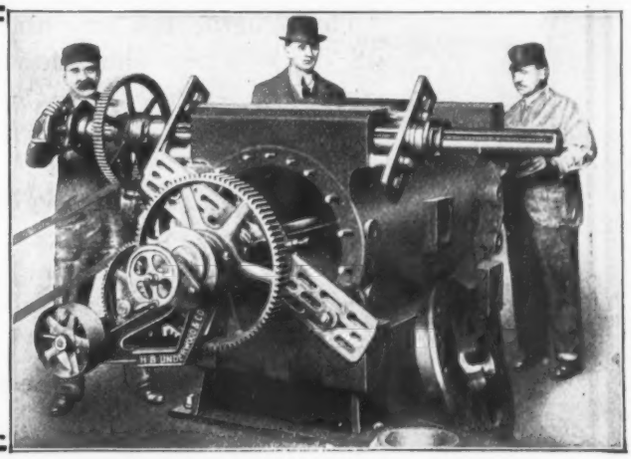
Our experts go *anywhere*, carrying with them their portable tools. Cylinders up to 120" rebored in position.

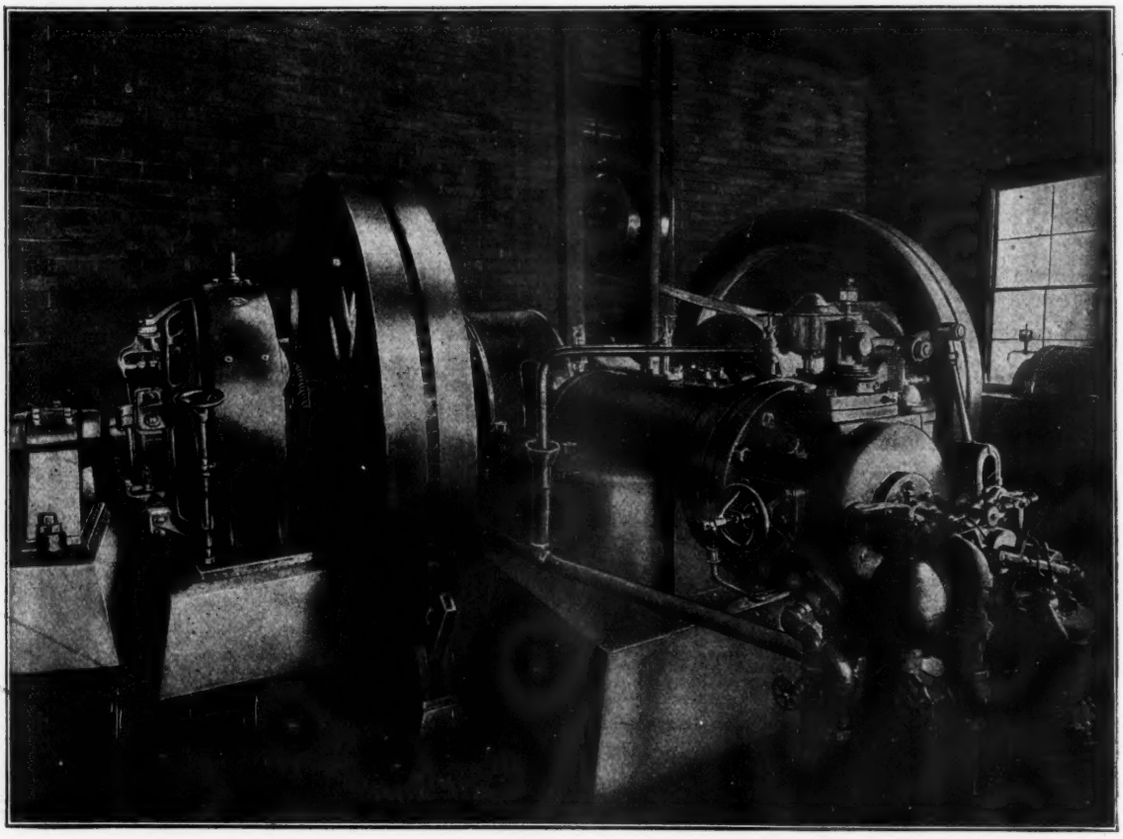
AMMONIA CYLINDERS INDICATED

H. B. Underwood & Company

ESTABLISHED 1870

1027 Hamilton St., Philadelphia, Pa., U. S. A.





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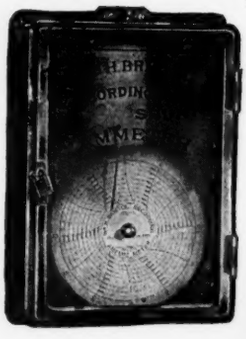

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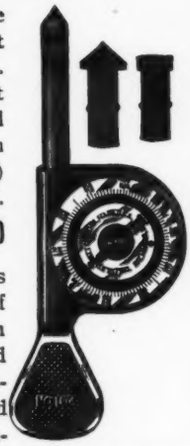

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